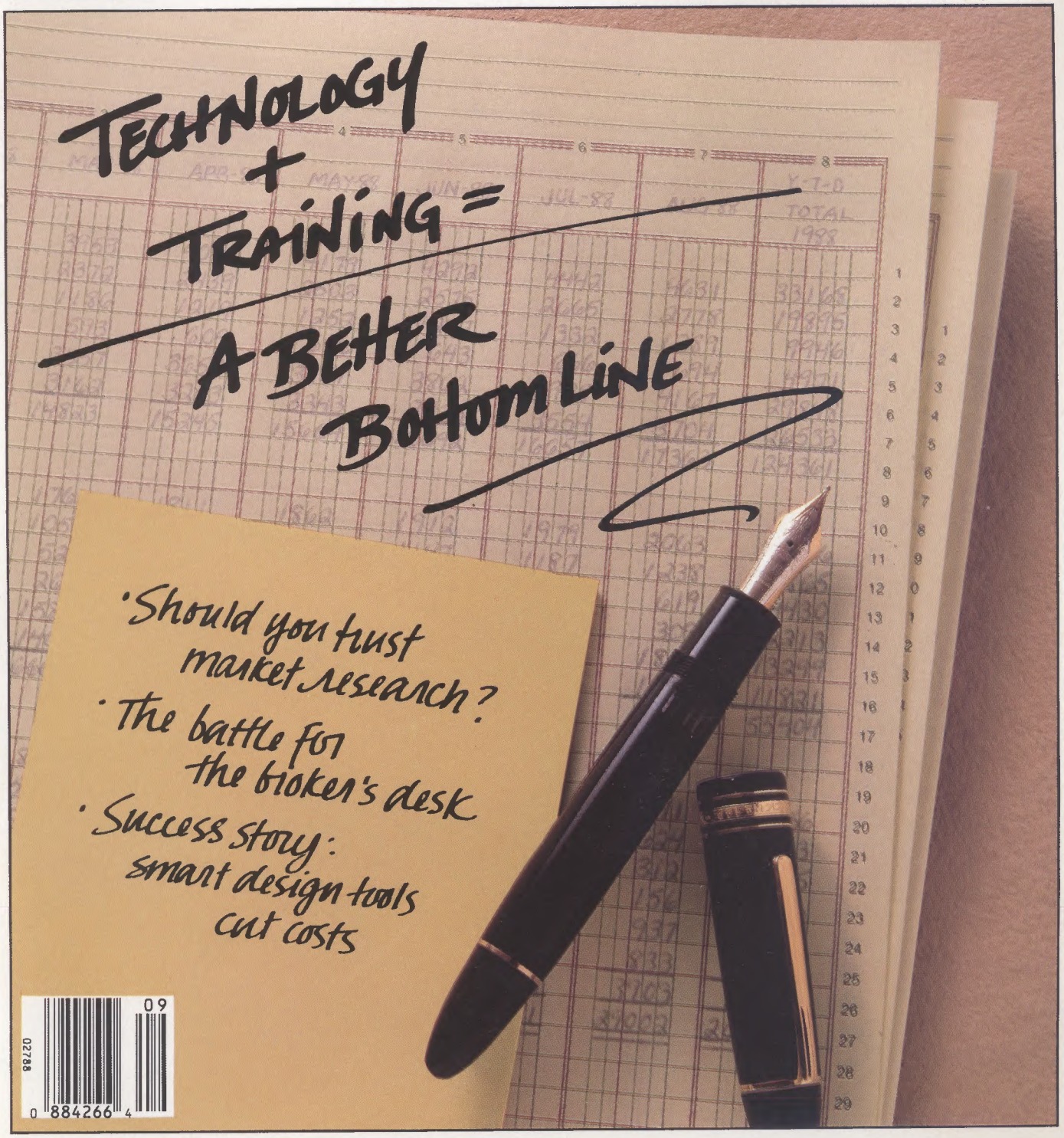
HIGH TECHNOLOGY BUSINESS

SEPTEMBER 1988

US $5.00/CANADA $6.00/UK £2.75



09
02788
0 884266 4

It has nothing to do with faster ships.

It has everything to do with a different, more streamlined way of manufacturing that helps you bring products to market sooner. It's called Computer Integrated Manufacturing (CIM). This new way of working goes beyond islands of automation to total integration. It uses technology not only to help individuals do their jobs, but also to help people work together more efficiently.

How can they beat us to market when we're already here?

No one is better able to help you start an integrated approach to manufacturing than IBM. In fact, we have the software, hardware, service and support to tie the whole thing together. And that's not just a lot of talk.

We have the successful customers to prove it. So if you'd like to find out how you can get your ideas to market sooner, call 1-800-IBM-2468, ext. 36. We'll help you take advantage of an advantage you already have.

IBM The Bigger Picture

A new computer system provides accurate, timely reports at an annual cost savings of $152,000. Designed and built by Hughes Aircraft Company, the Parts Logistics Analysis Network (PLAN) is used to track data on electronic components from their inception as engineering requirements through procurement, receiving, inventory, and the work cycle of Hughes satellite programs. PLAN "digests" requests for specific data banks, and promotes user control through "friendly" connections. PLAN also enables those who are most familiar with the data to manage the information, and requires minimal programmer intervention of system control languages.

Hughes has earned the 1987 Herschel Award for improving the sensitivity and producibility of infrared detector arrays. The technological breakthrough was achieved by using and adapting a process of liquid phase epitaxy developed by Hughes. Detector arrays make infrared imaging possible for applications such as satellite-generated weather and remote Earth sensing information, and night vision systems for military vehicles. The award is the highest yearly accolade given to an organization by the Infrared Information Symposia Specialty Group on Infrared Detectors.

Heat pipe technology will be used to cool future nuclear-powered space systems for the first time. Heat pipes are passive thermal control devices that are used to cool computers, signal processors, communications devices, and various other equipment in military and commercial applications. Under development by Hughes for NASA's SP-100 Advanced Radiator Program, the heat pipe's radiators will be as large as 8,881 square feet and will take on exotic shapes. Because they must be able to unfold after deployment from the Space Shuttle, the radiators will require the first-time use of heat pipes with rotating or flexible joints. The heat pipes' projected cooling medium will be a liquid metal, such as cesium, mercury, or potassium, and will operate at either 600 or 950 degrees Kelvin.

A new Space Based Radar Program will involve the placement of a constellation of sensor platforms in the Earth's orbit between 600 and 6,000 nautical miles in altitude for wide area surveillance of ships, aircraft, and cruise missiles. Hughes, as a member of the Grumman-led team, will define technology requirements and an implementation plan for the radar RF and processing sections, which will interface with Grumman's SBR system. An operational demonstration-validation phase will lead to a first launch in the mid-1990's. The Space Based Radar Program is a joint U.S. Air Force and Navy program.

Support Systems in Southern California designs, develops, and manufactures some of the most sophisticated training simulators and a wide array of automatic and manual test systems. In addition, field engineering and technical support of a wide range of electronic systems keep Hughes' systems operating at top efficiency worldwide. Opportunities are available for a variety of engineers qualified by degree or work experience. They include systems, radar, MATE control and support software engineers, logic designers and image processors. Please send your resume to Lowell Anderson, Professional Employment, Dept. S2, Hughes Aircraft Company, P.O. Box 9399, Long Beach, CA 90801-0463. Equal opportunity employer. U.S. citizenship required.

For more information write to: P. O. Box 45068, Los Angeles, CA 90045-0068

HUGHES

Subsidiary of GM Hughes Electronics

SEPTEMBER 1988
Cover photograph by Francine Zaslow
VOL. 8, NO. 9

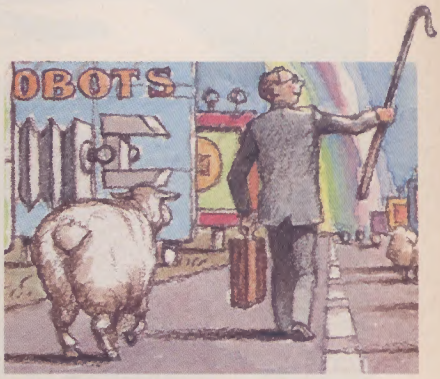
HIGH TECHNOLOGY BUSINESS

FEATURES

COLUMNS

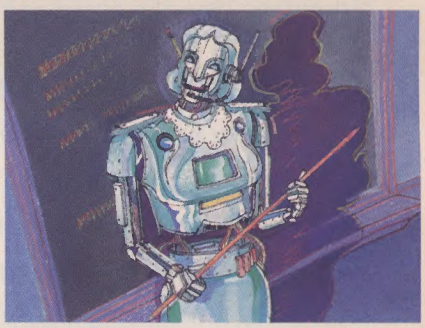
MARKETWATCH

DEPARTMENTS



Led astray by market research, p. 24.

Fighting to supply price-quote systems, p. 30.



High-tech training boosts the bottom line, p. 18.

HIGH TECHNOLOGY BUSINESS

PUBLISHER/EDITOR
Mark J. Estren

ASSOCIATE MANAGING EDITORS
Herb Brody, Fredric Paul,
Ed Warner, Jeffrey Zygmont

ART DIRECTOR
Ursula Beck

ASSOCIATE EDITOR
Francesca Lunzer

ASSISTANT EDITOR
Randy Ross

EDITORIAL PRODUCTION MANAGER
Gina Biancucci

COPY EDITOR
Diane Taraskiewicz

EDITORIAL ASSISTANTS
Elizabeth Aaron, Jennifer Christensen,
Kenan W. Woods

ASSISTANT TO THE EDITOR
Tamara Matthews

ART
Paul Weston, Associate Director
Bruce Sanders, Design Consultant
Julie C. Springer, Art Assistant

PRODUCTION DIRECTOR
Margaret A. Woisard

CIRCULATION
Felecia Carter, Kathi Rider

CONTROLLER
Douglas C. Dick

BUSINESS MANAGER
Maggie Erskine

EDITORIAL PROMOTION
Rochelle Ain

SYNDICATE SALES
Jennifer Battikha

RESEARCH
John Morse, Director
Mary Lennon

ASSOCIATE PUBLISHER
Robert Pavone

ADVERTISING
Mid-Atlantic: Frank Pascual, Regional Manager, 320 Park Ave., New York, NY 10022; (212) 891-7406. **Northeast:** Brian Rogers, Regional Manager, 320 Park Ave., New York, NY 10022; (212) 891-7411. **Southeast:** Mike Sullivan, Regional Manager, 13119 Burning Log Lane, Dallas, TX 75243; (214) 437-5124. **Northwest:** Bill Knickel, Western Advertising Director, Box 741, Saratoga, CA 95071; (408) 867-3430. **Southwest:** Lisa Sands, Regional Manager, 6701 Center Drive West, Los Angeles, CA, 90045; (213) 670-1100. **International:** Victor Webb, Marston Webb Intl., 60 Madison Ave., New York, NY 10010; (212) 684-6601.

Published by
INFOTECHNOLOGY PUBLISHING CORPORATION
320 Park Avenue
New York, NY 10022
(212) 891-7500

Technology's "Magic" Solutions

"Any sufficiently advanced technology is indistinguishable from magic," according to science and science-fiction writer Arthur C. Clarke. Indeed, translating the seemingly magical potential of high technology into the everyday world of business can be a complex, time-consuming task, with millions of dollars and thousands of jobs at stake. According to one estimate, an average young person entering the work force will change occupations four times in his or her career—and at least two of the jobs he or she will hold do not yet exist. As for current workers, three-quarters of those still in the work force by the year 2000 will need retraining.

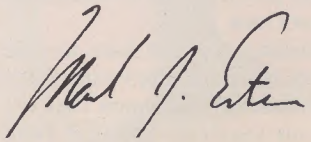
There is nothing magical about helping employees keep up with a changing workplace—training of some type has been around for as long as business has. But as the pace of change has accelerated, techniques to help employees and managers keep up have not themselves kept up—until now, when high technology has been put at the service of training. The result: new techniques to bring workers' skills to the bottom line more effectively (see our cover story, beginning on p. 18).

Of course, the speed of change varies from industry to industry—but there is no doubt that it is increasing, with high-tech approaches becoming the route to success in every sort of business, from the quintessentially white-collar (see "The Battle for the Broker's Desk," p. 30) to the industrial/manufacturing sector (see this month's Success Story, p. 39).

So a key question for all businesses is how they can predict where the marketplace is going so as to prepare to be in the right place, at the right time, with the right products or services. In the absence of a working model of a crystal ball, businesses frequently turn to market researchers to see what the future will bring. Market research itself has thus become a big business, and one of particular significance in the field of high technology, where the ability to perceive market direction and match products to developing niches can be critical to a company's future.

Unfortunately, market-research gurus tend to lead business executives like so many sheep—and the flock does not necessarily end up where the market researchers say it will. The result? See p. 24.

Change and technology, and the ability to predict where they are going, can become such a complex and distressing subject that anti-technology movements arise and flourish (see "Books," p. 14). But for all the potential problems it creates, high technology seems more and more frequently to be a solution for companies in all fields—a way to adapt to the pace of change rather than be overcome by it.



Relative Obscurity

I WAS QUITE amused by the reference to Convergent Technologies as a maker of "relatively obscure" workstations in the article "Designware Leader Faces New Threat" (April, p. 44).

Convergent has 500,000 obscure NGEN workstations installed with such obscure customers as the U.S. Army, Air Force, and Coast Guard, the Government Services Agency, McDonnell Douglas, Hughes Aircraft, Northrup, ADP Financial Services, Prudential-Bache Securities, and Bell South. We are a reseller-only company that works with such obscure vendors as Unisys, NCR, Groupe Bull, Prime Computer, and ADP. In addition, we are the number-two supplier of Unix multiuser systems, with about 90,000 in the field. The number of NGEN workstations we have in the field equals the number of DEC microVAX IIs.

Convergent is made up of outstanding customers, people, and products. If this is what you meant by "obscure," then I for one am happy to be part of such an obscure company.

Jim Cook
Manager, Market Development
Convergent Technologies
San Jose, California

Good Reading

YOUR COVER story for the June 1988 issue was OK, but the rest of the issue was *excellent*—the best issue I've seen yet. Thanks for the good reading.

Tim Sinnott
Fort Pierce, Florida

Impressive Punchiness

I WAS MOST impressed by Herb Brody's article "Picking Up the Pieces of RCA" in your May issue. As a once-upon-a-time stringer for UPI and others, I admire punchy, informative writing.

David A. Bershtein, Vice President
Corroon & Black
New York, New York

Clashing Views

IN HIS ARTICLE "Clash of the High-Speed Titans" (July, p. 48), Michael R. Leibowitz seems to have the idea that there are only two firms duking it out in the mini-supercomputer industry.

Floating Point Systems has been a major player in high-performance computing since 1974 and leads the mini-supercomputer industry in the number of machines installed. Since 1981, when we created the category, we have placed more than 400 mini-supers. We are far from the "fringe" company mentioned in the article. Our machines are faster than those of any of the companies mentioned in the article. Our top machine, the M64/145, can deliver a peak speed of 341 MFLOPS and is being used by customers now.

As a company that has been around for 18 years, we have more experience serving demanding customers than the others in our segment. Floating Point recently reached a definitive agreement to acquire the assets of Celerity Computing, which should further demonstrate our commitment to winning in this tough market.

Jeff Wilson
Public Relations Manager
Floating Point Systems Inc.
Beaverton, Oregon

Michael Leibowitz responds: *Although Floating Point Systems was certainly an early pioneer in scientific computing, it wasn't until Convex and Alliant introduced their stand-alone mini-supercomputers in 1984 and 1985 that the market took off. Today, the industry generally considers a mini-supercomputer to be a computer that offers one-quarter to one-half the performance of a supercomputer at roughly one-tenth the cost. Floating Point's products, in contrast, are attachments that boost the performance of an existing computer. Although these products were once the only game in town, they have lost their early momentum and have been greatly overshadowed by stand-alone products.*

Sensors in the Gas Tank

THE ITEM ON our Autofuel system in New Developments (June, p. 11) omitted one of the most significant non-military uses of this technology. The sensor system automatically compiles and monitors maintenance records for every vehicle in a fleet, permitting management to spot fuel-economy exceptions, unusual mileage records, and oversights in established service procedures. Also, the vehicle itself authorizes the pump to dispense fuel, so it becomes impossible to divert gasoline from fleet vehicles to private ones, even in the absence of an attendant.

Allan E. Mallenbaum
Vice President
Resource Network International Inc.
New York, New York

We welcome comments from our readers. Address letters to Editor, HIGH TECHNOLOGY BUSINESS, 214 Lewis Wharf, Boston, MA 02110. We reserve the right to edit letters for length and clarity.

Fly to Minneapolis and learn to surf.

Turn your business trips into free flights to Hawaii, the Caribbean, and Europe.

Next time you go to Minneapolis, don't just pack your attaché case. Dig out your surfboard. Dust off your camera. And get ready for your just rewards.

Because before you know it, you'll be cashing in on one of our great awards: Hawaii after only 40,000 miles; the Caribbean after 50,000; and Europe after 60,000.

And who knows, you may even earn our ultimate TWA award: two First Class tickets around the world.

If you're not a member of our Frequent Flight Bonus Program, call 1-800-221-2000, and we'll enroll you today.

Get unlimited upgrades without losing mileage points.

With TWA, you don't have to use mileage points to get upgraded to First or Business Class.

Just fly 5,000* actual miles and we'll give you an unlimited number of Business Class upgrades to anywhere in the U.S. Fly 30,000* actual TWA miles for unlimited upgrades to Royal Ambassador® First Class in the U.S. or to Business Class when you fly across the Atlantic. Of course, space permitting.

Earn bonus miles with every TWA VISA® card purchase.

Does earning one bonus mile for every dollar you spend on merchandise sound good to you? Then just stop by any TWA ticket counter and pick up an application for the TWA Visa® Card.

Once your application is accepted, you'll receive a free roundtrip upgrade certificate. And, if you charge a roundtrip TWA ticket and fly within the first six months, you'll get an additional 1,000 bonus miles.

So apply today. And make every dollar you charge bring you closer to your next award.

TODAY'S TWA. FIND OUT HOW GOOD WE REALLY ARE.℠

TWA

*TWA FFB® Program rules, offers, and award levels are subject to change without notice and are available in our membership guide. (During a 12-month qualifying period and available only on certain fares.)

New Developments

Issues, products and advances that help create new opportunities for high-tech businesses

- Microwave dryers save time and energy
- Grocery carts go video
- Patent backlog threatens biotech companies

Shoes With Built-in Bounce

THE LATEST buzzword in the athletic-shoe industry is "energy return." Sneaker companies are battling in their labs and television ads over whose energy-return technology is best: Nike's EVA (ethylene vinyl acetate), Tiger's Gel, Reebok's Du Pont Hytrel tubes, Etonic Tretorn's fiberglass Dynamic Reaction plate, or Converse's Energy Wave.

Conventional athletic shoes cushion impact, like pushing into a Styrofoam ball, robbing the runner of energy. The new designs, which cost anywhere from $40 to $110, aim to return much of that energy to the runner, pushing back like the bounce of a rubber ball.

Converse, based in North Reading, Mass., claims that experiments at the University of Lowell show that its Energy Wave design returns 50 percent of expended energy, more than any of its competitors. The company also says its shoes are 10 percent lighter than Nike's Air designs and will last almost four times as long—the equivalent of 800 to 1,000 miles of running. Converse claims its sneakers will let basketball players jump an inch higher and marathon runners shave several minutes off their time.

Not surprisingly, Reebok International of Canton, Mass., does not believe Converse has an edge over its energy-return sole material, a substance Du Pont uses in railroad-car bumpers.

HILL AND KNOWLTON INC.

Advanced athletic shoes return energy to wearers.

Martyn Shorten, director of the Nike Sport Research Lab, calls the concept "a big marketing ploy" and warns that some energy-return shoes may fall down in other areas, such as cushioning or support. No reliable tests have proven that energy-return sneakers are superior, adds Joseph Hamill, director of the biomechanics lab at the department of exercise science at the University of Massachusetts in Amherst.

—Elizabeth Aaron

An Easier Road To Chemotherapy

DISPOSABLE intravenous pumps are letting cancer patients get the treatment they need while still going about their everyday business.

More than 75 percent of America's 900,000 cancer patients undergo chemotherapy to kill cancer cells. Because these drugs must be taken through a vein, that has always meant costly and inconvenient hospital visits. Now there's an alternative—the Travenol Infusor, a disposable pump built by Alza Corp. of Palo Alto, Calif., and marketed by Baxter Healthcare of Deerfield, Ill.

Patients pick up the $35 device at the hospital pharmacy, pre-filled with their medication. The pump, about as long as a cigar, has a balloon reservoir that delivers the drugs to a thin tube. This tube leads to a tiny needle inserted into a vein in the arm. Patients wear the device under their shirt.

Baxter is also selling pumps to deliver antibiotics and painkillers. Three types are available—one delivers medication for 24 hours, another for five days, and the

third has a button to let people give themselves a dose of pain reliever whenever they need it. According to David Winchell, Baxter Healthcare product manager, the company sold 100,000 Travenol Infusors last year, bringing in revenues of $3.5 million.

—Francesca Lunzer

Home-Automaters Band Together

IN A BID to build a firm foundation for their industry, organizations with a stake in home automation have formed a trade group to exchange information and foster standards.

Charter members of the Home Automation Association board include Japan's Mitsubishi; X-10 USA Inc. of Northvale, N.J.; *Electronic House* magazine; Hometron of Washington; Hometronics of Indianapolis; and Heath Zenith of St. Joseph, Mich. The association has about 25 members, according to Mike Coffee, president of the group and an executive at Hometronics.

Coffee says the association is an umbrella organization, not a proponent of any particular approach to home automation. Formed in Dallas last January, the group looks at building codes and building standards that affect home automation, rather than promoting specific products. The goal, Coffee says, is to balance the need for industry-wide standards against the interests of competing equipment manufacturers who want to protect their proprietary systems.

The Home Automation Association will include end users and installers as well as manufacturers, Coffee says, and is actively seeking new members.

—Fredric Paul

Drying Clothes With Microwaves

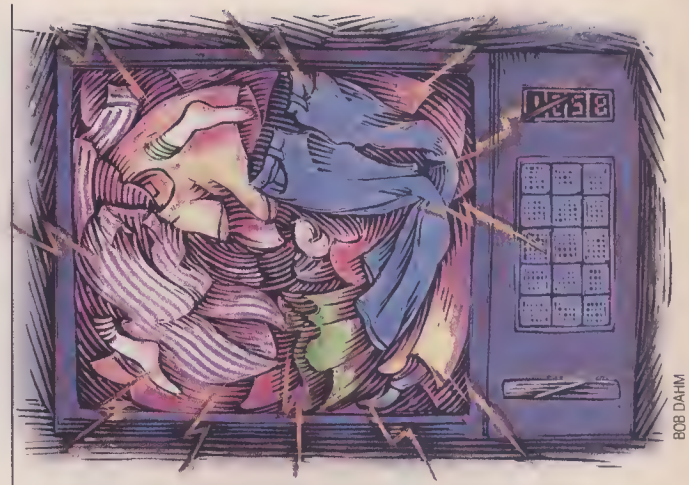
A COMPANY called Micro Dry Inc. hopes to have its microwave dryer under Christmas trees in 1989.

This Tulsa, Okla., startup plans to use microwave energy to evaporate water in fabric, drying a load of clothes 30 percent faster than a conventional gas or electric dryer while using less energy. Temperatures in a microwave dryer would reach only 95° to 110° Fahrenheit—35° to 70° lower than in a conventional dryer. The machine would heat only the clothes, not the dryer itself, and need no vents. It would plug into any wall socket.

To make its concept a reality, Micro Dry wants to license a manufacturer that has "a knowledge of microwave technology and the art of drying," says president Paul Kantor.

The microwave dryer will initially cost 15 to 20 percent more than an equivalent conventional dryer, but Kantor points out that microwave-oven prices have fallen drastically since they hit the market in 1967.

—Kenan Woods



BOB DAHM

INFORMATION RESOURCES INC.

The VideOcart aims to take the boredom out of shopping trips.

Televisions Go Grocery Shopping

A SCREEN for grocery carts may help supermarkets steal customers from competing stores. The VideOcart, made by Information Resources Inc. (IRI), is a 6×8-inch touchscreen hitched to a standard shopping cart. Customers get an eyeful of recipes, store maps, trivia games, and, of course, plenty of advertising. Chicago-based IRI supplies the equipment, and hopes to recoup its investment by selling advertising time—at $100,000 a pop.

IRI will send computer-generated ads to the supermarket manager's personal computer via satellite. The information will then travel to low-power transmitters in the store's aisles. As customers wheel their carts around the store, the screen will pick up ads for items displayed in that aisle. IRI can target ads for particular audiences or stores, and store managers can play ads for their market's own sale items.

IRI hopes to reach 60 percent of the nation's shoppers by putting screen carts in each of the 10,000 supermarkets that gross at least $4 million a year. The company plans to test market the VideOcart this fall in Chicago and on both coasts.

The VideOcart may mollify shoppers caught in long checkout lines and replace the mess of newsprint circulars. But Paul Combs, an analyst at William, Blair, worries that the gadget may distract shoppers.

—Elizabeth Aaron

Look at All The Channels

ONE OF THE first benefits of digital television was "picture-in-picture" technology—the ability to use part of the TV screen to view a second program while continuing to watch the first. Now, several television sets and videocassette recorders are using picture-in-picture technology to let viewers sample everything else on the air.

Sony's new 46-inch projection televisions display freeze-frame insets of seven channels along the left side and bottom of the screen, and update those images every four seconds. Sharp's VC-D800V television covers the entire screen with nine freeze-frames and includes the channel numbers.

SHARP ELECTRONICS CORP.

Digital TV feature may make *TV Guide* obsolete.

A system from Toshiba, available on the CZ-2898 TV, shows still views of 16 channels at a time, but doesn't update them; the company's SV-970 Super-VHS videocassette recorder offers nine views. Zenith offers a similar feature that displays three channels, and the VR9780AT Super-VHS recorder from Philips Consumer Electronics lets viewers choose scenes from four, nine, or 16 channels.

All these models are high-end products, and will cost quite a bit more than a year's subscription to *TV Guide*.

—Fredric Paul

'Chemical Cow' Tests Bull Fertility

THE University of Wisconsin in Madison has developed a fertility test for checking a bull's potency. The Chemical Cow lab test recreates the chemical environment of a cow's reproductive tract to evaluate a bull in just nine hours; conventional tests take 60 to 90 days.

Farmers could use the test to rank the fertility of breeding bulls, which can bring in $1 million in a season. Currently, 60 percent of U.S. cows—10 million head—are artificially inseminated.

Human fertility tests are also expensive and time consuming, and the Chemical Cow's developers hope one day to use the process to check people.

—Kenan Woods

Microwave Scalpel Cuts Blood Loss

AN ELECTRONIC scalpel being tested by the EPIC Health Group emits microwaves to help close blood vessels while cutting. The microwave scalpel should reduce blood loss, often a serious consequence of surgery.

An antenna in the scalpel's blade emits a low level of microwave energy that burns the tissue around the incision as it is made, cauterizing it to stop bleeding. This reduces blood loss when surgeons operate on organs rich in blood vessels, such as the spleen, liver, and pelvic area. The microwave cauterization leaves a strong, thick scab that allows scar tissue to form and prevents the wound from opening up again.


EPIC HEALTH GROUP

Scalpel cauterizes as it cuts.

Past methods of cauterization, including lasers, sutures, and electricity, have not been completely effective in sealing off blood vessels quickly or permanently during operations. When the microwave scalpel hits the market in 1990, it is expected to be considerably cheaper than older technologies: $15,000 to $20,000, compared to $30,000 to $40,000.

The technology for the microwave scalpel, invented in 1985, is also expected to help remove tumors previously thought to be inoperable, says Dr. Martin J. Kaplitt, medical director of EPIC, which is based in Elmsford, N.Y. The device's inventor, University of Maryland professor Dr. Leonard Taylor, says the technology has also been used to power a dissecting tool, which will be available with the scalpel.

Doctors have successfully used the microwave scalpel in six operations, and tests are continuing at six East Coast universities and medical centers.

—Julie C. Springer

Computers Help Confused Voters

BLAMING computers for making the world incomprehensible is a popular pastime. But a group of sociology professors at the University of Utah in Salt Lake City are using computers to help voters make educated decisions in national, state, and local elections.

The group formed I Vote Corp. to offer a service that processes information about candidates for political office. Gerald Smith, one of the company's founders, says participants first receive a packet outlining the relevant issues for a particular election. Voters indicate where they stand on the issues, and I Vote processes the responses, comparing the candidates' views to those of the voter. The service then sends the data to voters so they can see which politicians best support their opinions.

In a 1986 pilot study, 85 percent of the participants said the new information would change their votes. Smith is currently looking for a sponsor to franchise the I Vote program in major cities throughout the country. He also points out how the I Vote program could help political parties, special-interest groups, and businesses educate voters about which candidates most closely support an organization's political goals.

—Jennifer Christensen

Electric Filters Stop Clogs

RESEARCHERS at Battelle Memorial Institute have found that electrifying filter membranes can cut clogging by 30 to 70 percent. Retrofitting electromembranes to existing filtration systems could extend the life of filters used in the food, pharmaceutical, chemical, biotechnology, and electronics industries.

So far, Battelle has added electricity only to plastic membranes, but electromembrane-product manager William Huffman says the process should work on ceramic and bipolar membranes as well.

A commercial electromembrane product would add about 10 to 25 percent to the cost of an original system and pay for itself in a year, says Huffman. He estimates that the first product, for flat-plate filters, will be available in two years. Models for spiral, hollow-fiber, and reverse-osmosis membranes should follow shortly after. Battelle, based in Columbus, Ohio, has applied for a patent and is exploring commercial prospects.

—Jennifer Christensen

Patent Backlog Bad for Biotech

BIOTECHNOLOGY companies have the most to lose from a growing backlog of patent applications. The U.S. Patent and Trademark Office, called "a regulatory never-never land" by U.S. Representative Ron Wyden (D.-Ore.), now has about 11,500 biotech cases pending final action, a six-year load. The problem will probably get worse; the Patent Office expects the number of new biotech applications to increase at 12 percent a year well into the 1990s.

Last year, biotechnology companies filed for more than 5,000 patents. Many applications came from small outfits whose livelihood depends on quick action from the Patent Office. Some companies have decided to market their products without patent protection, and risk someone stealing their inventions, rather than lose important funding. A PaineWebber survey of 48 biotech-company prospectuses found that 93 percent cited uncertainty about patent protection as a discouraging factor in investment.

Patent Commissioner Donald Quigg counters that relief has been available all along for companies that need a patent quickly, "particularly those that are thinly capitalized and may depend on patent ownership to attract additional investment capital." Companies can get their applications examined out of turn in special situations such as the advanced age of the inventor, ongoing infringement of the invention, or reliance on the patent for investment decisions. Of all the biotech applicants in 1987, only 17 filed petitions for accelerated examination last year, says Quigg.

—Kenan Woods

ALSO WORTH NOTING

POINTER SYSTEMS INC.

Here's looking at you, keyboard.

- Originally developed for disabled people, the FreeWheel from Pointer Systems moves a computer cursor according to head movement. An iridescent fixture about the size of a quarter, worn on the forehead or atop eyeglasses, sends infrared light beams to a small camera mounted on the computer screen. The camera detects the beams and instructs the computer where to send the cursor. Pointer Systems, based in Burlington, Vt., claims the $900 FreeWheel works with a wide variety of software on Apple Macintosh and IBM PC-compatible computers. For disabled users, Pointer Systems includes ScreenKey, a keyboard display window that lets users type with the FreeWheel pointer in a variety of software programs. The program automatically finishes commonly used words to allow speedier typing.
- Zila Pharmaceuticals Inc. of Phoenix, Ariz., has developed a polymer-based ointment to relieve the pain of fever blisters and mouth ulcers. The waterproof gel, called Zilactin, contains tannic acid to soothe pain and forms a thin film around the irritation. This film acts as a bandage to keep the tannic acid in while protecting the sore from fluids and food for as long as eight hours.
- Despite rapid advances in signal compression, full-motion video still cannot travel over ordinary telephone lines. Progress in compressing sound, however, may soon allow transmission of FM-quality audio over telephone lines, according to N.S. Jayant of AT&T Bell Laboratories. The Integrated Services Digital Network (ISDN), an advanced phone system now beginning to be installed in this country, can handle more than 128 kilobits of information per second, which may soon be enough to carry high-fidelity music.
- In an effort to catch up with the Japanese in the development of high-definition TV, U.S. broadcasters and standards organizations have formed the Advanced Television Testing Center near Washington to examine the various formats now available. Eddie Fritts, president of the National Association of Broadcasters (NAB), says the center uses donated equipment and receives funding from ABC, CBS, NBC, PBS, and the NAB. The center has also asked cable-TV organizations to participate, and is inviting all proponents of advanced TV systems to submit them for testing. The center plans to conduct surveys to ask the general public which system is best, and to find out how much consumers might be willing to pay for it.

Ceramic Engines

JAPAN LEADS RESEARCH ON CAR MATERIALS

By Robert Chapman Wood

TINY CERAMIC blades, weighing just 100 grams each, enable turbocharged Nissan cars sold in Japan to accelerate about as quickly as a Porsche 944, according to Nissan. Yet some of these Nissan models cost only about $20,000. The dramatic benefit of the tiny blades illustrates Japan's lead in automotive technology and the country's particular strength in new materials. The impressive results of this lead are now starting to reach the market.

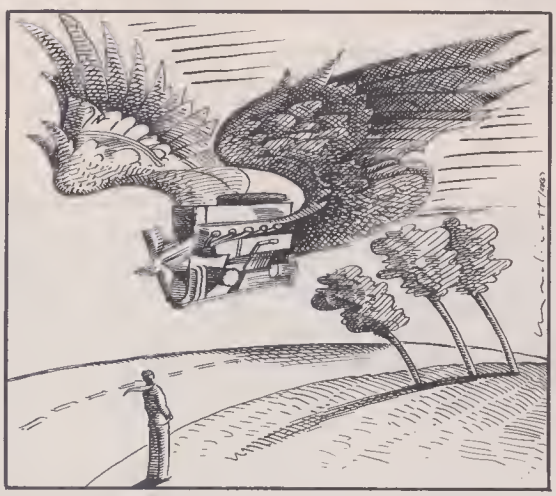
Japanese carmakers have long integrated research and development into the heart of their organizations. These companies seized the world lead in automotive research back when they could afford to spend only about half as much on research as did their U.S. counterparts. Japanese managers believe they get great value for their research investment, and Japanese research spending on automobiles is expected to soon surpass the U.S. level.

Unlike U.S. carmakers, who closet their research teams in the lab, Japanese research projects often begin with suggestions from production and marketing people. Not only do the Japanese mine a rich lode of good ideas, but the close relationship among various company sections make production and marketing more receptive to the fruits of research. By 1985, Toyota, Nissan, and Honda were each taking out more U.S. patents than were previous world leaders General Motors or Ford. Japan's increased spending suggests that its research lead will continue to grow.

Materials research is a top priority for carmakers worldwide. New materials, especially lightweight ceramics, promise to revolutionize automotive engines and perhaps auto bodies as well.

A prime example is the advent of ceramic turbocharger blades. Turbochargers force more air into an engine's combustion chamber, producing a more powerful piston stroke. To withstand the stresses involved, turbo blades have traditionally been made of fairly heavy metal. The blades' weight slowed their response, delaying the car's acceleration in an effect called "turbo lag."

Ceramics, however, can be made lighter and stronger than metal. Nissan's latest cars use ceramic turbo blades with 35 percent less mass than the nickel-alloy blades used in conventional turbochargers, says Nissan spokesman Miki Kurosu. The ceramic turbocharger cuts turbo lag significantly. Bench tests show the ceramic turbo reaches peak boost pressure 0.7 seconds faster than a conventional turbocharger. The Nissan Skyline GTS accelerates from 0 to 100 kilometers per hour (62.1 miles per hour) in 7.2 seconds.



JAMES ENDICOTT

Both Japanese and U.S. scientists hope to eventually use ceramics for most auto-engine parts, including the valves and the valve train. Ceramics' tolerance of high temperatures allows more efficient combustion with less need for lubrication and cooling.

Unfortunately, engineers have only begun to understand the physical and chemical properties of ceramics. The best ceramic parts perform superbly in the lab and as prototypes, but even the Japanese cannot consistently produce dependable ones. Nissan makes its ceramic turbocharger blades of injection-molded silicon nitride hardened by firing. Many of the blades come out too brittle, so Nissan and its suppliers must perform extensive tests on each one.

Production of turbochargers with ceramic blades began three years ago with a limited edition of the 300 ZR, the Japanese version of the 300 ZX sold in the United States. Nissan is the only company producing ceramic turbochargers and does not sell them outside its home market. Today, the largest-selling ceramic-turbocharged car is a luxury sedan, the Cima, which costs more than $40,000 and has astounded the Japanese auto industry by selling more than 6,000 units per month, according to Toshihiro Nishiguchi, a research fellow at the International Motor Vehicle Program at MIT.

The Cima's dramatic success demonstrates ceramic turbocharging's ability to contribute perhaps as much as $500 million a year to Nissan's bottom line. Nishiguchi predicts that the engines for the next generation of Japan's middle-market cars, such as the Toyota Corolla and Camry, will also use advanced ceramic materials in their engines.

Research genius is only one battle in the automotive war, but carmakers have had to learn to monitor Japanese technology, just as the Japanese once turned to the United States for inspiration. Japanese technology will change the way the world drives, and U.S. auto-parts suppliers, in particular, face a tough battle to stay competitive.

Robert Chapman Wood is a writer and business consultant who specializes in the economies of the Orient.

Why Businesses That Moved, Moved To North Carolina.

Economics: "It had to make economic sense. Our new headquarters would require 340,000 square feet and we didn't have a great deal of time. The building costs were 80% of a 20 major city average. For construction of our building, we found good quality workmanship, willingness to work longer hours to keep the project on schedule, and aggressive bidding for all contracts. The decision to move was finally made for economic reasons." *Garret J. Dykhouse, CPCU, Vice-President, Royal Insurance*

Garret J. Dykhouse, CPCU, Vice-President, Royal Insurance

Labor: "You've got to consider a multiplicity of reasons. Ours is a new facility so construction costs were a consideration and quality of life is always important. Another tremendous factor was the willingness on the part of the state to train our workers in voice and data communications through the community college system. But most important was the available labor force. The skill level of that labor force was ultimately the reason we chose North Carolina." *Kenneth R. Croft, Manager of Public Affairs, American Express Travel Related Services*

Kenneth R. Croft, Manager of Public Affairs, American Express Travel Related Services

People: "After making an analysis of 13 U.S. cities, we chose Charlotte, N.C. for our Eastern Operations Center. A large part of our decision was based on the business attitude and that attitude extended to the people of Charlotte. They were there every step of the way, helping with business services, site selection and anything else we needed. We received great cooperation from both state and local government. Their whole attitude towards business, their cooperation and the way they helped...they really went out of their way to be an integral part of our relocation." *Donald L. Black, Senior Vice-President, Home Savings of America, FA.*

Donald L. Black, Senior Vice-President, Home Savings of America, FA.

Whether you're looking for important human services, business oriented tax structures, distribution and financial opportunities, labor and resource availabilities, or a wealth of natural beauty, you'll find all of this and much more in North Carolina. So, if you're thinking about moving, let us show you some more reasons to move to North Carolina. Just contact Robert G. Brinkley, Assistant Director-Business/Industry Development Division, North Carolina Department of Commerce, 430 North Salisbury Street, Raleigh, NC 27611, phone (919)733-4151.

NORTH CAROLINA

The Better Business Climate

Moving Forward, or Back?

DEBATING THE MERITS OF TECHNOLOGY

■ **By Mark J. Estren**

The Conquest of the Microchip
by Hans Queisser.
Harvard Univ. Press, 212 pp., $24.95.

The Electronic Sweatshop
by Barbara Garson.
Simon & Schuster, 288 pp., $17.95.

It is no coincidence that Mary Shelley's warning against untrammeled technology in her novel, *Frankenstein*, was followed by the Luddite movement, in which British workers rioted and destroyed labor-saving textile machinery because they feared job loss and dehumanization. Words have power, and can and do provoke action, for better or worse. Demagogues understand this better, alas, than do people who believe in quieter and more thoughtful discourse.

TOM LULEVITCH

The Luddites have been gone for nearly 175 years, but their spiritual descendants are still very much with us. So are people like Barbara Garson, who seek the words to rouse them. The descendants of Dr. Frankenstein are with us, too, endlessly searching to extend the sphere of human knowledge. But nowadays, thank goodness, the quests of people like Hans Queisser are tempered by a sense of wonder, a sense of humor, and a sense of social responsibility—qualities notably lacking in Dr. Frankenstein himself.

The contrast between those who hate and fear technology and those who see in it a blueprint for a better future could scarcely be clearer than it is in the case of these two books and their authors. Queisser has impeccable scientific credentials: he is director of the Max Planck Institute for Solid State Research in Stuttgart, West Germany, and was one of the original researchers who worked with William Shockley on the development of the transistor. Garson is an author and playwright whose works appear frequently in newspapers and popular magazines, and who is perhaps best known for her play *Macbird!*—which suggested, tongue somewhat in cheek, that Lyndon Johnson arranged the murder of John Kennedy so Johnson could become president.

Queisser's book is science and technology writing at its best. He has a sense of history—witness his charming retelling of the story of how shoemaker Vincenzo Casciarolo of Bologna discovered fluorescence, circa the year 1630. But he is also well aware of modern business problems, such as that of getting the marketplace to accept new technologies. Writing about the first years after the development of the transistor, he notes, "Scientists saw the dawning of a new age, but engineers were much less inclined to such poetic views, and carefully calculating businessmen remained unimpressed."

But there are, of course, constituencies other than scientists, engineers, and businessmen—for instance, the people for whom Garson writes. Her book is a series of simply written anecdotes about how dehumanizing technology is. Garson interviews worker after worker who feels victimized by computer-based systems that, Garson argues, are treating today's white-collar workers the way blue-collar assembly-line workers used to be treated: as a series of easily replaceable parts.

Garson does pay lip service to the value of technology: "There are many ways to combine the efficiency of computers with the skills and talents of human beings." But she clearly prefers broad-brush negativism: "All over the world, technology is controlled undemocratically by people who scorn, fear or simply want to use their fellow human beings."

Garson and her ilk are incapable of sharing Queisser's joy in pushing back the frontiers of knowledge—a joy that is, to be sure, tempered by awareness of scientific excess. But Queisser's words and worries are those of a thoughtful, concerned scientist/citizen, not of someone guilty of controlling technology undemocratically. Indeed, Queisser would deplore such a state of affairs. As the best scientists do, he looks at macrocosmic issues even while working in the world of the minuscule. Garson, on the other hand, is so immured in her microcosm that she makes it hard to pay attention to the genuine issue of human replaceability on white-collar assembly lines that she raises.

It is depressing to realize that the entertaining tone of Garson's book is likely to give it more currency, and give its words more power, than will be accorded Queisser's far more erudite and reasoned work. Appeals to Luddite feelings do have a certain demagogic attraction. Those who believe in technological progress for the benefit of humanity can console themselves with the knowledge that the 19th century Luddites were not, in the long run, successful, and that their movement now seems little more than an aberration. ■

Most Market News Is History. OTC NewsAlert℠ Is History In The Making.

The Leaders Of Tomorrow Are On-Line Today...With OTC NewsAlert.

If you live and breathe OTC, OTC NewsAlert can help you live better—and breathe easier. Because OTC NewsAlert brings you the news and information you need today to spot the Fortune 500s of tomorrow.

Created to serve the special needs of OTC pros, OTC NewsAlert delivers the news as it happens. So you can make things happen—fast. Which is why so many professionals already rely on OTC NewsAlert for up-to-the-minute market intelligence.

The On-Line Source For Comprehensive News On Over 16,000 NASDAQ & Pink Sheet Companies.

All day, every day, OTC NewsAlert brings you late-breaking news and full-text press releases about today's contenders and tomorrow's comers. So you can spot what's hot—and what's not—hours, sometimes days before the competition.

Instant Access & Continuous Tracking of the Stocks You Most Want To Watch.

Whether you're following favorites in an emerging industry or tracking market-maker issues, OTC NewsAlert makes it easy for you to find what you need when you need it—instantly...and for up to six months afterward!

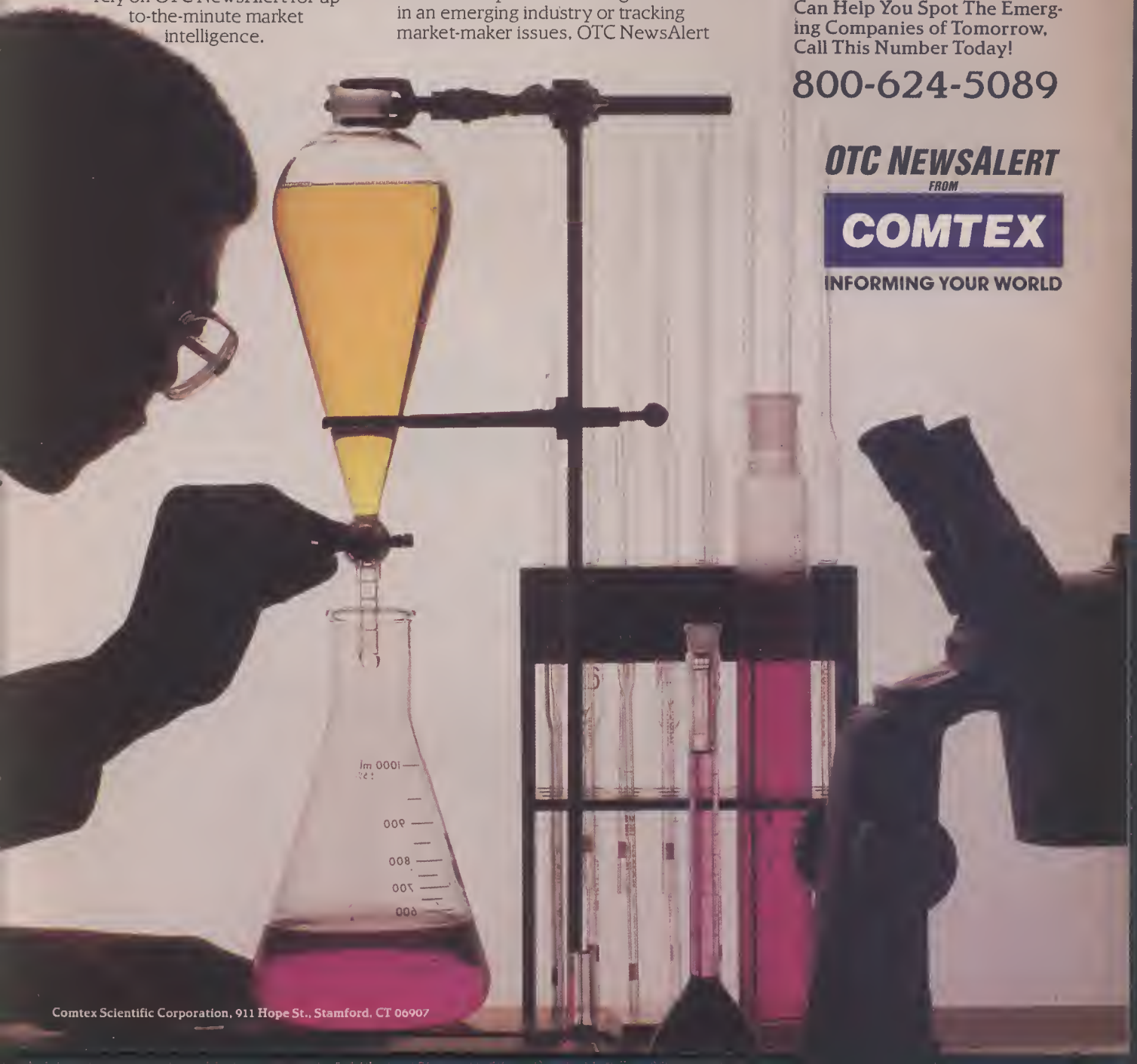
Hard-To-Get News of SEC Filings, IPO's...and More!

Filings are at your fingertips with OTC NewsAlert. Whether it's insider trades, purchases of 5% or more, declarations of intent to file, or the full range of SEC forms and schedules, OTC NewsAlert reports the events to you—as they happen!

To Learn How OTC NewsAlert Can Help You Spot The Emerging Companies of Tomorrow, Call This Number Today!

800-624-5089

OTC NEWSALERT
FROM
COMTEX
INFORMING YOUR WORLD



Comtex Scientific Corporation, 911 Hope St., Stamford, CT 06907

Regulation Calling

PROPOSED PHONE PRICE CAP STIRS DEBATE

■ **Judith St. Ledger-Roty**

THE FEDERAL Communications Commission believes its plan to regulate telephone-service prices instead of profits will spur investment in new technology and lead to lower prices through competition. The phone companies generally agree, but opponents worry that the plan will have the opposite effect.

The FCC now regulates the profits of AT&T and the local phone companies by controlling their rate of return on investment—allowing them to recover their costs, plus a specified profit margin. (In recent years, that margin has been kept to 13.75 percent, even during periods of high inflation.) The commission regulates how much the companies can charge so that their return won't exceed these limits.

MARK KSENIAK

In what many observers are calling the most significant development in telecommunications regulation since the breakup of AT&T, the FCC is proposing to set the maximum and minimum rates AT&T and the Bell operating companies can charge, regardless of how much it costs them to provide services. Rates could go up or down 5 percent per year without review. The FCC would also permit yearly rate adjustments to reflect changes in the Gross National Product, productivity, and cost changes beyond a company's control.

Not surprisingly, the telephone companies love the idea. The 5-percent-per-year cap means that they could raise their rates by 20 percent over four years with near impunity from regulatory interference.

Even if the phone companies exercise restraint, it's clear that the abolition of rate-of-return regulation could prove extremely profitable. In Maryland, which instituted statewide price-cap regulation over AT&T, the company's rate of return has apparently soared. According to the Maryland People's Counsel, AT&T garnered a return on investment of 125 percent. AT&T claims its rate of return was "only" 48 percent.

The price-cap plan would also free phone companies from periodic FCC cost reviews. Under rate-of-return regulation, the FCC checked to make sure the companies' investments and assumptions were reasonable, and sometimes decided they were not. Since 1986, disallowances of claimed costs have totaled hundreds of millions of dollars. According to the FCC, "in the last two years alone, [the commission has] disallowed more than $163 million in dominant-carrier [AT&T and local phone companies] investments and ordered switched access charge reductions of over $1 billion."

The FCC and other supporters say that, in addition to spurring investments, the price cap will encourage more efficient operations because it will let a telephone company keep profits from new services. Despite the plan's freedoms, the FCC doesn't think the phone companies will inevitably raise their rates, but expects competition to force carriers to reflect cost savings in lower rates.

Congress, state regulators, consumers, and competitors to AT&T and the local phone companies are not so confident. The Consumer Federation of America (CFA) contends that "consumers run a significant risk of paying unreasonably high charges for telecommunications services under price-cap regulations as proposed by the commission." One basis for this position is that telecommunications is a declining-costs industry; the real cost of providing phone services is estimated to have fallen 40 to 60 percent in recent years. The CFA and other critics contend that, under a price cap, carriers would have little incentive to lower their rates to reflect decreased costs. This possibility is of particular concern in the local-service arena, where state regulations protect the phone companies from competition.

Detractors also argue that consumers have already paid the bill for implementing new technologies, including fiber optics and digital switching, and therefore rates should go down. Finally, opponents contend that the plan will decrease investment in new technology, because phone companies will have little incentive to deplete profits by investing in network facilities.

Opponents in Congress have drafted legislation that would preclude the adoption of price caps by the FCC before 1989, when the current incarnation of the FCC will be replaced by the next administration. Bowing to congressional pressure, the FCC recently asked for further public comment on the proposal. But, without congressional intervention, the FCC clearly intends to adopt its controversial plan.

Judith St. Ledger-Roty, a partner in the Washington law firm of Pierson, Ball & Dowd, represents telephone users, manufacturers, and service providers.

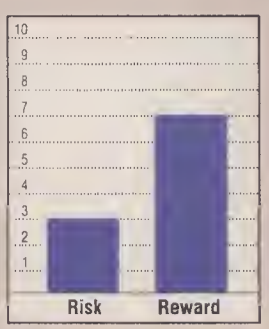
HIGHTECH TOMORROW

For Those Who Understand The Link Between Information and Profit

Because these times demand the highest caliber of investment advice, HighTech Tomorrow brings you the recommendations of those experts with the rare ability to consistently sort the winners from the losers in any kind of market. Bull or Bear.

United Telecom Inc.'s current stock price of $30 fails to reflect the continued turnaround of US Sprint. United Telecom owns half of Sprint, and the convalescence of the long-distance carrier should push its parent com-

Each issue, they'll direct you to the real opportunities in high technology—the handful of companies with the drive to succeed even under the most volatile circumstances. And in all the hot areas.
In computers.
In defense technology.



In biotechnology. In communications.

Clear, cogent analysis that lets you take advantage of opportunities long before other investors.

If you're one of those who seek profit in the high-tech sector, we offer you a distinct advantage—information you can profit from in any economic climate. Which is why HighTech Tomorrow is one of the most sought-after sources of high-tech investment advice available.

And why we can help you make investments that stand the test of time.

United Telecommunications (NYSE:UT)
2330 Shawnee Mission Pkwy., Shawnee Mission, KS 66205. (913) 676-3000

1. 1987 Revenue	$2.4 B
2. Estimated 1988 Revenue	$2.5 B
3. Earnings Per Share:	
last quarter	$.29
last fiscal year	$.55
4. Estimated Earnings Per Share:	
next quarter	$.40
next fiscal year	$1.90
5. Recent Stock Price	$30
6. Target Price (6-12 Months)	$38

Please begin my one-year subscription (12 issues) to HighTech Tomorrow for ~~$129.00~~ $99 (check enclosed). I understand that I can cancel my subscription for any reason whatsoever and receive a full refund on all unmailed issues.

Name _____

Address _____

City _____

State _____ *Zip* _____


HIGHTECH TOMORROW
Investment opportunities from Wall Street's top analysts.
Proposed Regulations Should Boost Profits for Phone Company
US Sprint's Turnaround Stems Losses at Parent Company

5HTT9

Send to: HIGHTECH TOMORROW, 214 Lewis Wharf, Boston MA 02110

Technology Tackles The Training Dilemma

Computers and interactive-video systems are changing the way American business copes with training

BY RANDY ROSS

TRAINING HAS been a problem for businesses since business began. In the earliest days, people learned from one-on-one instruction; craftsmen served apprenticeships and the children of the wealthy learned essential skills from private tutors. Head-to-head training is still probably the most effective method ever developed, but it's useless for teaching large numbers of students. When the Industrial Revolution created a need for an educated work force, schooling came to the masses in classrooms governed by a new type of educator—bespectacled Miss Crabtrees wielding chalk in one hand and a hickory switch in the other. Such classes could handle large numbers of students, but quality suffered because Miss Crabtree had to slow down lessons to accommodate the weaker students.

At last technology is providing solutions to the training dilemma, with methods that don't compromise quality for quantity. New methods rely on "interactive" technologies that adjust to the individual student, just as an attentive tutor would. And they're fast. Experts claim that computer-based training and interactive video can cut training time in half.

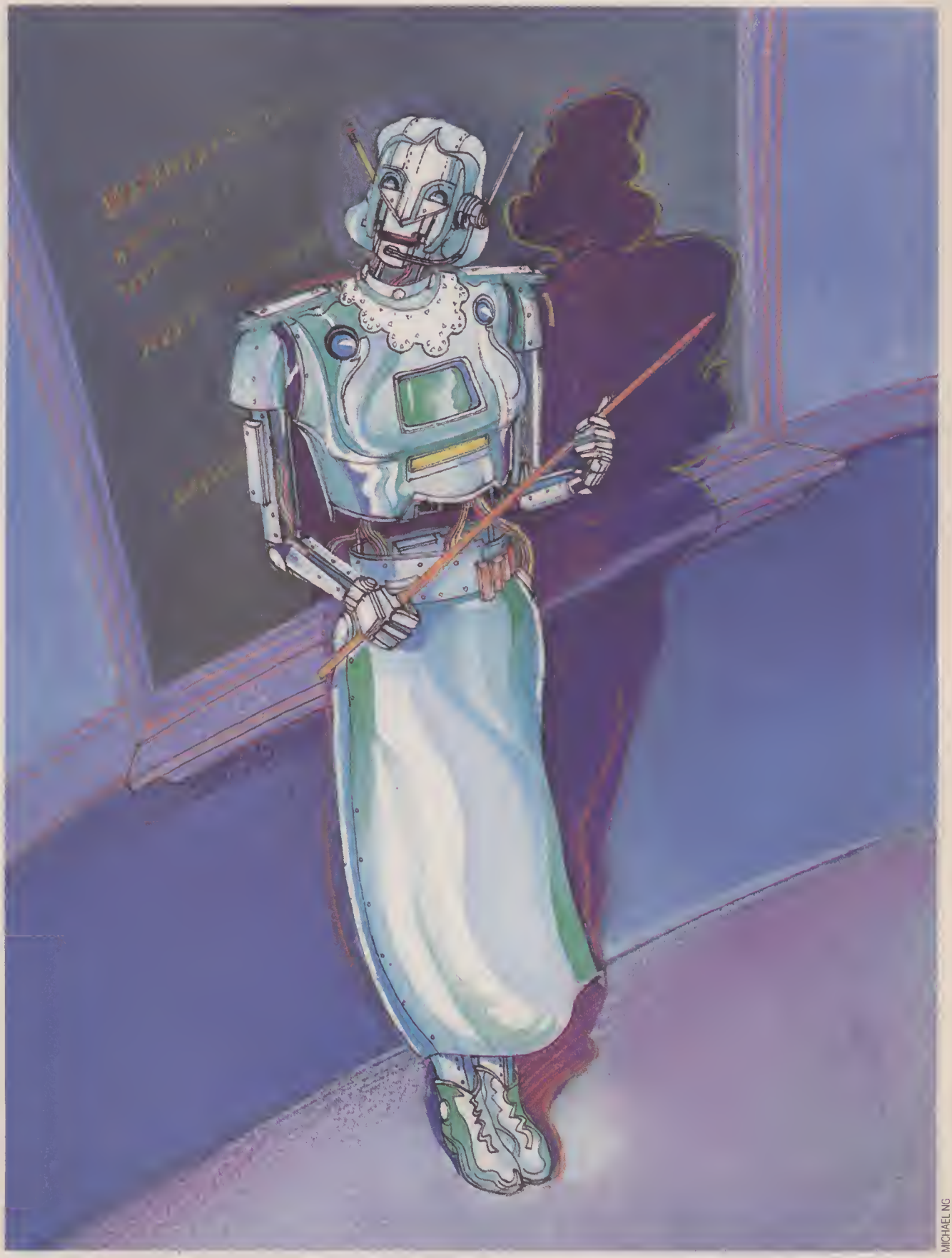
Both computer-based training and interactive video rely on computer technology to gear training to students' needs. For instance, a worker learning how to repair computer equipment may be presented with a lesson followed by a quiz. An incorrect answer on the quiz cues the computer program to send him to a remedial section that helps him find the correct answer. However, people who understand the material can race through from start to finish at a faster pace. Such learning programs are interactive because a student's responses determine the sequence of the training interactions. Also, workers can tackle training at any time, as long as a personal computer or interactive-video monitor are at the ready.

When large companies need to reach many employees scattered across the country, teleconferencing and business-owned TV networks are rapidly becoming the method of choice. Private broadcasts let a company's best instructor reach all the pupils at the same time (see "Business TV Becomes Big Business," May 1988).

These advanced training technologies come not a moment too soon. Faced with increasing international competition, businesses need well-trained workers now more than ever, especially businesses that depend on complicated and often confusing technologies. What's more, in this cost-sensitive era when companies must get by with slim staffs, training can play an essential role in getting the most from the remaining workers.

The need for training will only intensify. Business and industry is changing so fast that, among today's workers who make it through the year 2000, about 75 percent of them will need retraining. Young people now entering the work force will change occupations about four times during their careers, and at least two of those occupations don't exist yet, according to the *Training and Development Journal*. Combine a shrinking pool of entry-level workers with the 23 million American adults who are considered functionally illiterate, and it's clear that more corporations will offer basic education in the workplace.

Already, U.S. businesses spend about $30 billion on education and training each year, according to an estimate from the American Society for Training and Development. Training expenditures should increase 5 percent per year for the next five years, predicts Stuart



MICHAEL NG

INTERACTIVE VIDEO AT XEROX

Xerox saves $6 million each year by training its 15,000 field-service technicians with interactive video discs. Not only is this technology cheaper than earlier methods, but it is proving more effective, because the technology presents information in a format that Americans respond to almost instinctually: television.

Spectrum Interactive of Bedford, Mass., developed Xerox's training program, called Exploring Computer Systems. The software teaches skills from computer basics to repairing local-area networks. Technicians awaiting service calls now can turn inactivity into productivity by learning from slick lessons on one of 10 interactive video discs. Each exercise is about three minutes long; the entire program takes about six weeks to complete. Interactive video discs provide random access to information, which means that users can work at their own pace and skip ahead, go back, and pick up where they left off.

A quiz/review follows each lesson, and after a few lessons, the program gives a test and suggests ways to improve. The system tracks student learning with scores, and reports employee progress to a database at Xerox headquarters. "If you can measure service readiness, you can manage it," says David Snow of Spectrum Interactive.

The training software cost Xerox about $1 million to produce, plus $3 million for the hardware, which does double duty for other video-disc applications. Xerox has installed 500 desktop workstations in 140 training centers and customer-service sites around the country. A workstation consists of a Xerox model 60605 personal computer, Sony or Pioneer video-disc players, video discs, a Zenith touchscreen monitor, and a Tecmar video controller board.

Xerox claims that it saves about $300 to $600 per trainee each day, considering the price of accommodations and lost work time during classroom training. The new method reduces training time by 30 percent and increases the learning rate by 40 percent, according to the company.

With results like these, Xerox's commitment to interactive video discs as a training technique has grown to the point where the company has established Service Education Centers in Rochester, N.Y., and Leesburg, Va., to create its own video-disc programs. Spectrum Interactive, previously called Interactive Training Systems, is helping out. Spectrum boasts $300 million in annual sales.

—Jennifer Christensen

MICHAEL ULLRICH

Krasny, president of California-based SK&A Research.

Those training dollars pay for a range of approaches—no-tech methods such as seminars and workbooks; low-tech techniques, including videotape and film; and high-tech alternatives such as interactive computer software and laser-disc systems.

Among the high-tech methods, computer-based training—interactive systems consisting of a computer and training software—accounts for a whopping 30 percent of the corporate training dollar, Krasny says. Interactive-video systems, which use a computer, video-disc player, and a 12-inch laser disc, now take only about a 2 percent slice, but are growing. By 1992, interactive video will cut into demand for instructors and videotape, and account for about 8 percent of the training market, according to Krasny.

Similarly, teleconferencing, which transmits lessons to many remote sites simultaneously, accounts for about 2 percent of corporate training expenses. Krasny expects that figure to double to 4 percent over the next four years. By that time, even more advanced training technologies should be in place. Systems being developed by such heavyweight researchers as General Electric and Sony Corp. will use compact discs with digitized images to give workers access to large databases.

Even though machines may never match the love Miss Crabtree put into her lessons, high-tech training methods handle many tasks more efficiently. A 1984 study conducted by IBM showed interactive video to be about three times more effective at teaching than an instructor, and consultants claim that computer-based training teaches one-third faster than do standard, instructor-led classes.

Another benefit of machine instruction is that it increases one-on-one interaction. The oft-quoted axiom holds that we recall 25 percent of what we hear, 45 percent of what we hear and see, and 70 percent of what we do. Interactive video and computer-based training force students to participate, which can be a feat in itself. "In first grade, people learn how to get by without paying attention," notes Gloria Gery, author of *Making CBT Happen* (the "CBT" stands for computer-based training).

Other advantages of high-tech teaching include consistency, efficiency, and economies of scale. "Trainers are human, and have good days and bad days," says Thomas Reeves, assistant professor of instructional technology at the University of Georgia. A machine that delivers a prerecorded lesson has no such variation—management can be sure that each employee receives the same information every time. In addition, by eliminating tangents, interactive technology can reduce class time by one-third, says Ruth Clark, a California-based training consultant.

Further, students can save their companies time and money by using self-paced instruction that lets them skip lessons they already know and focus on unfamiliar material. Faster learners get back on the job sooner; slower learners can redo a lesson until they get it right, without appearing incompetent in front of peers or wasting class time.

Even though interactive video is dwarfed by the number of computer-based training systems installed, it represents an up-and-coming training method. The technology uses a video disc read by a laser, similar to audio compact discs that play music, but packed with images and controlled by a microcomputer. A student uses a keyboard to respond to questions, options, or problems presented by the program on the disc.

The major benefit of interactive video is its ability to provide television-like, full-motion pictures. These are hard to beat when teaching behaviors, such as

how to act on a sales call, or for demonstrating hands-on skills that are difficult or dangerous to undertake in real life. Video simulations are used to teach everything from how to handle a nuclear-power-plant disaster to emergency medical care.

However, the high cost of hardware and video production typically limit interactive video to organizations with deep pockets, such as governments and large corporations. "If you're not training [at least] a thousand people, I'm not sure you can justify [customized] interactive video," says Charles Hall, sales manager for Interactive Medical Communications of Waltham, Mass. Interactive-video hardware can add about $4,500 to the cost of a personal computer, or total about $9,450 for an integrated system such as the IBM InfoWindow. Major hardware suppliers include IBM, Sony, and Matrox Electronic Systems Ltd. of Dorval, Quebec. Custom-made interactive-video software can cost about $200,000 to $450,000, according to Richard Michaels, vice president of Learncom, a company in Cambridge, Mass., that makes training software.

When it's available, generic, off-the-shelf software can be considerably cheaper. Interactive Medical Communications, a $12-million company that makes only interactive-video products, offers a series of generic programs that teach Occupational Safety and Health Administration standards, for about $1,700 per program. The company also rents hardware; a complete package can cost as little as $125 per trainee.

For companies that can afford the up-front investment for hardware and software, the long-term payoff from interactive-video training can be substantial. A system used by the U.S. Army cuts training time by almost 50 percent for computer repairmen who must learn to maintain and repair disc drives in Digital Equipment's VAX minicomputers. Formerly, an instructor needed three days to train 15 people, giving each student time on the computer. The interactive-video system lets instructors teach 15 people in less than two days. Instructors can cost $400 a day, so this can represent a substantial savings.

Such savings in time and expense account for the sudden pickup in the popularity of interactive video. Applied Learning Inc. of Naperville, Ill.—probably the biggest player in the fragmented training industry, with about $200 million in annual sales—has seen its interactive-video revenues jump from $3 million in 1985 to an anticipated $80 million this year. "Interactive video is replacing live education," says company president William Roach.

The U.S. Army has been a major benefactor of the technology and recently signed a hardware contract with Matrox that could be worth as much as $223.5 million over the next five years. At Fort Benning in Georgia, an interactive-video system simulates tank warfare, eliminating hazards to soldiers and damage to expensive equipment. On one occasion, trainees using actual tanks drove into a river and several people drowned, recalls Thomas Reeves, assistant professor of instructional technology at the University of Georgia. The tanks also wore paths in the ground that were easy to follow, allowing drivers to cheat. No such problems arise during a computerized simulation.

Interactive video is also making significant inroads in sales training, because it can demonstrate body language and other visual cues important in approaching a customer. Massachusetts Mutual Insurance Company of Springfield, Mass., uses a system that trains agents, and then videotapes their performance in various sales situations. Agents may retape the exercise as many times as they like, then show it to

BUSINESS TV AT COMPUTERLAND

When Amdek Corp. of San Jose, Calif., began selling its computer systems in ComputerLand stores earlier this year, its stable of sales and service dealers increased by 250 percent overnight. However, representatives from the stores had to travel to either Dallas, Chicago, New York, or Santa Fe, N.M., to learn how to service Amdek goods. Consequently, some dealers never got certified—bad news for a company whose products compete for shelf space against the wares of IBM, Compaq, and Apple.

Enter ComputerLand Television, or CLTV, a two-year-old private satellite network that reaches more than 260 ComputerLand outlets affiliated with the Hayward, Calif., retailer. With a single two-hour CLTV program, Amdek authorized 275 dealers around the country. "That's a huge accomplishment," says CLTV manager Albert Maggio. "It has taken IBM continual training and programming to get that many dealers up and running."

The speed of Amdek's accomplishment underscores the primary benefit of teleconferencing—its ability to transmit information to large numbers of people at the same time. Maggio thinks Amdek was able to grab some important market share with its program. "It doesn't mean the stores will sell Amdek instead of IBM, but it gets them out there," he says. "When the opportunity arises, they are at least being considered."

From its studios in Oakland and San Mateo, Calif., the ComputerLand network beams programs to satellites, which relay signals to individual stores. Viewers can catch programs that include authorization training, new-product introductions from computer companies, and desktop-publishing seminars. Using a toll-free telephone number, viewers can call the instructor with questions.

Stores pay $100 a month for the service, which includes programming, installation of the satellite receiving dish, service, and maintenance. Dealers save the travel-related expenses usually associated with one-on-one training. ComputerLand says that if dealers are using the network the way it is currently set up, they save $1,000 a month. One store owner claims he saved $3,000 by certifying two technicians through a CLTV program similar to Amdek's.

Maggio admits that if a company has the time, money, and resources available, face-to-face training will probably always be the best technique. But "not all companies have those resources," he says, "and CLTV helps smaller companies compete and get their information into the stores in a uniform fashion."

—Kenan Woods

COMPUTER TRAINING AT GUARDIAN

Faced with the nagging problem of staff turnover—35 to 40 percent of its sales personnel leave each year—Guardian Life Insurance Co. used to tie up the time of its more productive employees with training newcomers. Not only did that steal time from workers, but it also spawned large travel bills getting people to centralized training centers.

A year ago, the New York-based company began its conversion to computer-based training. Training supervisor John Flanagan says the software has enhanced the training program by helping to increase productivity, and by making it easier to keep staff abreast of changes. It may even help Guardian reduce turnover, he says, because employees who understand their work better are inclined to stay at their jobs longer.

Guardian placed a $100,000 order with Sandy Corp.'s Learncom division in Cambridge, Mass., for off-the-shelf software that helps managers in regional offices set goals, evaluate office performance, plan project strategies, and improve math and writing skills. Learncom also developed custom software for the claims and sales departments. Guardian is so pleased with the high-tech training that an interactive video program is in the works.

At the moment, Guardian still uses classroom and videotape training, but Flanagan expects computer-based training to eventually eliminate classroom lessons. When using training software, employees don't get lost in the crowd; students who give wrong answers to questions are referred automatically to the appropriate sections of the program for review.

The software's learn-test format speeds learning and helps trainees retain information, especially when combined with video, says human resources and planning development director Daniel Riordan. Guardian expects the higher level of interaction of its coming interactive-video program to help employees retain even more.

Another benefit, says Riordan, is that the software's standard teaching approach assures that every employee gets the same information presented in the same way. The software also adapts to users at any level, points out Learncom vice president Richard Michaels.

A drawback, however, was the need to invest in IBM PS/2 personal computers to run the software, recalls Riordan. The company had used only IBM XT and AT computers before.

One major, though unsought, benefit of computer-based training came when Guardian recently cut staff at its claims offices. Effective training was essential to compensate for the loss of experienced people, says Riordan, and the training software has allowed the offices to maintain productivity with fewer people.

—Elizabeth Aaron

a supervisor for a critique. The $15,000 system includes a touchscreen monitor, a laser-disc player, a color camera and video recorder/player, and an IBM AT personal computer, all housed in a portable cabinet.

The Massachusetts Mutual system cuts training time by about half, says Jane Curtis, director of field development. At one field office, the system contributed to a 40 percent increase in agent productivity, as measured by sales results.

Because laser-disc video systems offer greater interaction, they could eventually replace videotape in the training industry. However, it will be at least five years before disc systems make serious inroads. At the moment, videotape is the training industry's most popular technology. A survey by Minneapolis-based Lakewood Research found that 80 percent of the trainers polled use videotape, compared to 35 percent who use computer-based training systems, and 3.9 percent using interactive video.

ACTV of New York is developing an interactive videotape system that may help the older technology hold on even longer, particularly as companies seek to maximize the return-on-investment of their tape equipment before buying laser-disc hardware. The ACTV system is being developed for the consumer market, but may find its way into training by the end of the decade, says Rockley Miller, editor of *The Video Disc Monitor* newsletter. The device can read one of several parallel tracks on the videotape, allowing the program to branch into various areas in response to student inputs. The interactive tape would run on a conventional videotape player equipped with a "black box" to read the specially coded tape.

Nevertheless, the technology still has limits for training, says Miller. In particular, videotape can't hold a still image for very long, and the tape cannot easily go backward when a student's performance indicates the need for review—something that's a snap with random-access video discs.

Computer-based training systems lack the visual capability of interactive video, but their lower cost makes them attractive alternatives for teaching cognitive tasks such as memorizing a body of knowledge or learning the steps of a procedure. Generally, computer-based training consists of either custom or generic software on a floppy disk that runs on a conventional personal computer. Custom programs can cost $40,000 to $70,000, about one-fifth the price of comparable interactive-video software, says Michaels of Learncom, which also sells off-the-shelf software ranging from computer literacy to project management for less than $200.

Prudential Insurance Company of America uses a computerized training program to prepare agents for the National Association of Security Dealers licensing exam. The company hired Longman Financial Services Institute Inc. of Southfield, Mich., to develop the program. When agents were taught in classroom lectures, only about 68 percent passed the exam, says John Murray III, Prudential's vice president of research. With the computer-based training program, the pass rate jumped to almost 90 percent. The program has also helped Prudential deal with rapid agent turnover: Its agents are more content after passing the exam, be-

cause the license lets them sell products such as mutual funds and variable annuities that boost commissions.

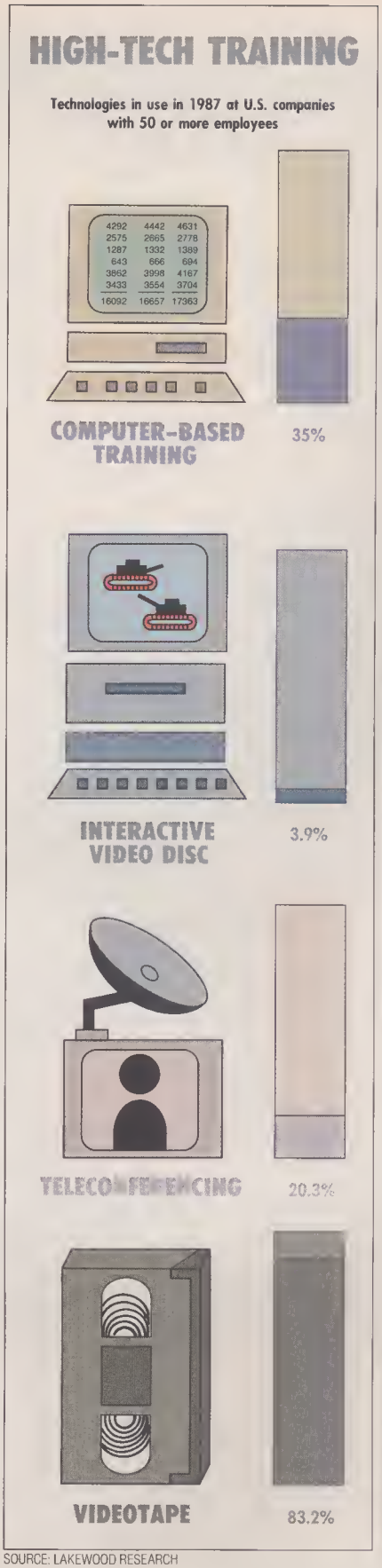
Computer-based training also is used extensively for management training, especially for exercises that simulate business situations. Such exercises let managers practice running various divisions of a company—operations, finance, research and development—without making real-life judgment errors that could damage the company. During a typical simulation, participants divide into teams that are given the responsibility of running a fictitious company. The computer program crunches through the data and provides quick feedback on the imaginary company's profits and competitive position, based on the management decisions made by the players.

When immediacy is an issue, teleconferencing continues to be the best way to get the word out. On the evening of last October's stock-market crash, several financial services and brokerage firms, including Merrill Lynch, used private television broadcasts to contact brokers scattered across the country. "In situations like that, the savings cannot be measured," asserts Elliot Gould, publisher of the industry newsletter *Telespan*.

More tangible savings from teleconferencing come from reductions in training-related travel. Using a business TV network, companies can broadcast training programs to employees at their workplaces.

Although business TV is widely considered a successful training technology, its high price limits it mainly to large companies. Installing a private network can cost more than $1 million, plus ongoing operation and production costs. And even though satellite-telecast programs reach large, dispersed audiences, they are basically an extension of the auditorium-lecture approach. Interaction between lecturer and worker is limited to the few telephone calls that may get through to the studio. "A trainer couldn't possibly handle all the calls. He probably gets a tenth of 1 percent," says Ron Zemke of *Training* magazine.

In the near future, training will be delivered on adaptations of compact-disc players. Like video discs, compact discs store data as a digital pattern of pits on the disc's surface. A laser reads the pits, which are then decoded and presented as pictures on a screen, sound through a speaker, or data on a computer monitor.



SOURCE: LAKEWOOD RESEARCH

Compact discs, which are technically the same as the 4¾-inch CDs used in home stereo systems, can store vast amounts of data—one disc can hold the equivalent of the information available on 1,500 floppy disks.

Compact disc-interactive (CD-I), being developed by Philips, in cooperation with Matsushita and Sony, combines limited interactive video with large databases. SK&A Research's Krasny says CD-I could be useful for teaching sales people who must sell a wide array of products from a catalog, such as those from large department stores or auto-parts dealers. In addition, at about $2,000 for a complete system, CD-I hardware would cost about one-third the price of a comparable video-disc system. CD-I is expected to hit the consumer market in mid-1989, and possibly the training market in another year after that.

General Electric is developing an alternative to CD-I that can deliver moving pictures, but experts say the picture quality is not up to snuff. This technology, called digital video interactive (DVI), uses add-on boards to coordinate a personal computer, a CD-ROM drive, an amplifier, and speakers. The add-on boards could add approximately $7,000 to the cost of such a system. DVI technology, which is expected to reach the consumer market in 1990, can accommodate more full-screen, full-motion video than CD-I.

Although compact-disc technology represents the next wave of training technology, it's still too early to speculate on when it will arrive. The training industry has been slow to accept interactive technologies, and, as one executive put it: "You can't hit them up every year with a new gadget." The acceptance process could be accelerated when CD systems are able to provide acceptable moving images; until then, many software developers may ignore CD technologies.

But even the most sophisticated, readily adoptable, technology will not put Miss Crabtree on the unemployment line. In the future, instruction may involve a machine that delivers the lesson and a person who handles problems and can therefore spend more time with trainees. The bottom line: Miss Crabtree will become more efficient and her students will become more productive. ■

ANN GOFFIN-SMITH

Sorry, Wrong Number

Market-research firms routinely mispredict the course of technology businesses. Why do executives still listen?

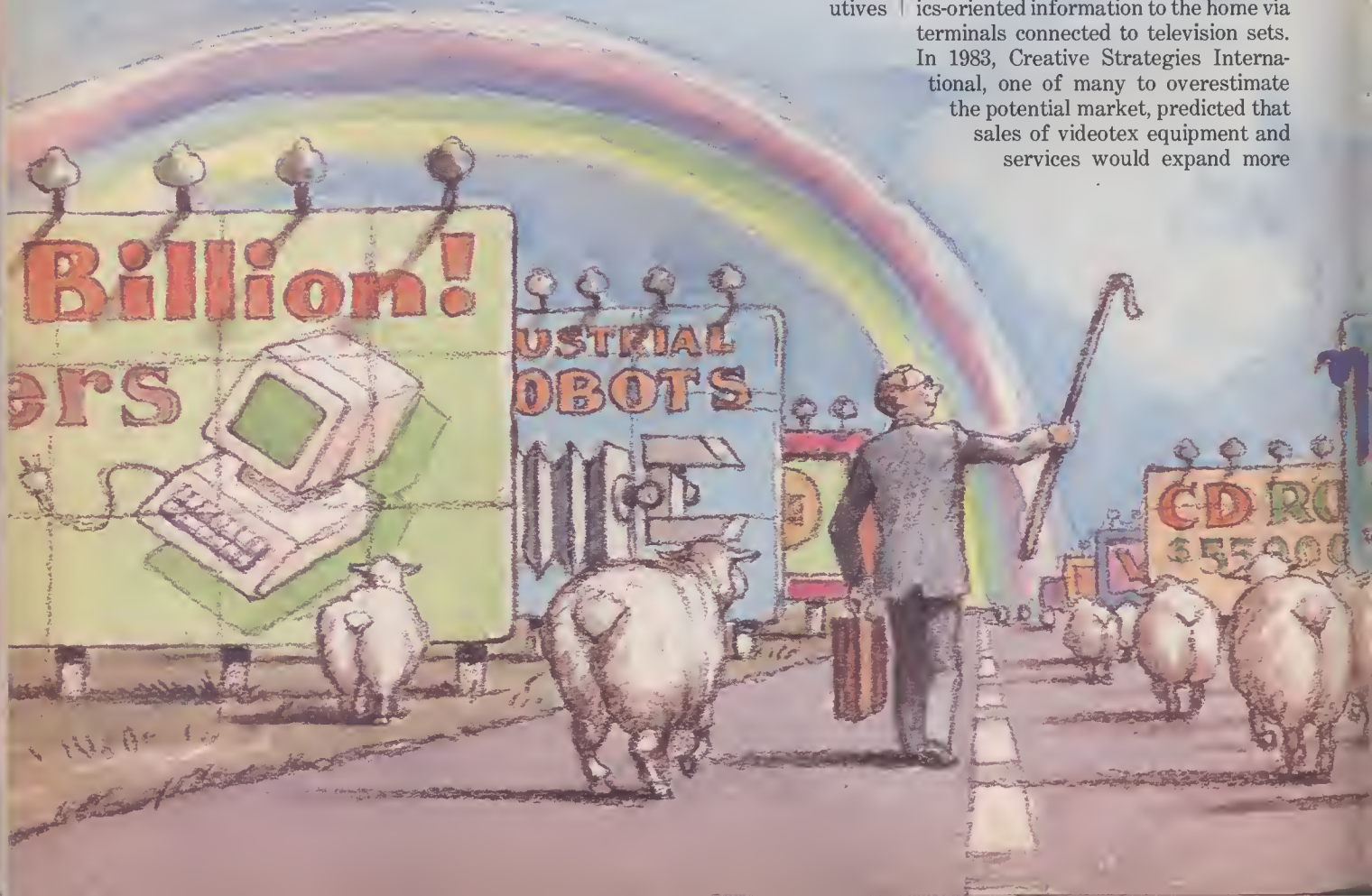
BY HERB BRODY

SUBMITTED FOR your approval: A world where friendly androids patrol homes, robots run factories, and home computers have replaced the daily newspaper. This Twilight Zone scene is the world of 1988 as predicted by technology-market forecasters.

Even though these prognostications are more often wrong than right, they are widely read and quoted. High-technology industries seem to need to be soothed as they embark on inherently risky ventures. To quench this thirst for numbers, reports and studies flow from market-research organizations such as Dataquest, the Gartner Group, and International Data Corp.

Sales projections often have a tantalizing aura of authority. Executives and managers gobble them up before committing company resources to grand new projects, and entrepreneurs use them to win investments from venture capitalists. Meanwhile, reporters disseminate the figures until the numbers take on a life of their own.

Erroneous forecasts can hurt companies that rely on them. The Knight-Ridder newspaper company, for example, lost $55 million in an attempt to market videotex, a system for delivering graphics-oriented information to the home via terminals connected to television sets. In 1983, Creative Strategies International, one of many to overestimate the potential market, predicted that sales of videotex equipment and services would expand more



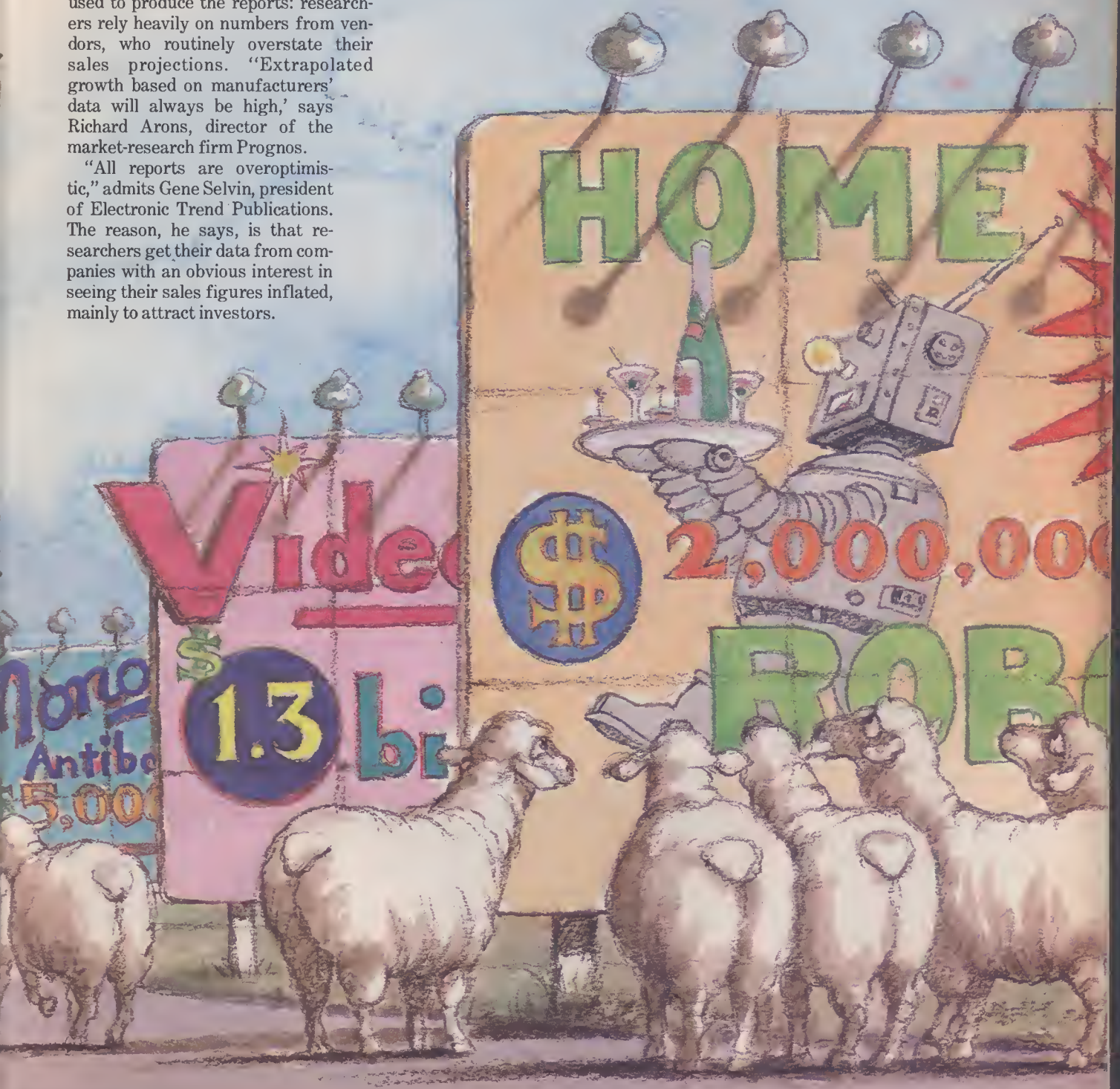
than 90 percent annually, reaching $7 billion by 1987. But a trial system convinced Knight-Ridder that the pundits were living in a fantasy world. After two years, the company declared defeat and walked away. "We saw no way to make the service profitable," says Virginia Fields, Knight-Ridder's vice president for news and circulation research.

Why do the scenarios painted by market researchers bear so little resemblance to conditions in the real world? The answer lies partly in the means used to produce the reports: researchers rely heavily on numbers from vendors, who routinely overstate their sales projections. "Extrapolated growth based on manufacturers' data will always be high,' says Richard Arons, director of the market-research firm Prognos.

"All reports are overoptimistic," admits Gene Selvin, president of Electronic Trend Publications. The reason, he says, is that researchers get their data from companies with an obvious interest in seeing their sales figures inflated, mainly to attract investors.

Prab Robot president Walter Weisel knows only too well the fallibility of technology market forecasts. His company was one of many that expected the robot business to soar to the billion-dollar level by 1990. However, after a quick start, robot sales have sputtered. Industry revenues for 1987 amounted to only about $300 million—just one of numerous wrong calls that have damaged the credibility of forecasters.

Good researchers discount overoptimistic sales projections by subtracting a "fudge factor"—the level by which a vendor consistently exaggerates its claims. Reputable research firms also balance their results by polling potential customers, gaining data that is more reliable but far more difficult to gather. The problem: As few as 3 percent of the users polled respond to surveys, says International Data spokeswoman Shelley Bakst. Generally, it is much more time-consuming and expen-



sive to survey a technology's potential customer base than to poll the much smaller set of vendors.

Misleading information flows from laboratories as well as from sales offices. Scientists and engineers, infatuated with their technologies, sometimes delude themselves about commercial practicality. Materials scientists, for example, are now touting the wonderful qualities theoretically achievable with a new class of metal-matrix composites. However, "if you say, 'make me a piston,' they scratch their heads," says Richard Bryant, senior industry analyst at Business Communications.

Usually, the fault lies with the market researchers' naivete and with their need to unearth good news. Buyers of market research typically want the numbers to support a decision to enter a new business area; the more optimistic the predictions, they feel, the more useful the report. "We regularly get pressure to say a market is bigger than it is," says Ralph Finley, executive vice president of Dataquest.

Indeed, says Finley, it is difficult to sell reports that make conservative projections. Dataquest found only about a half-dozen customers for a 1984 report foreseeing slow sales of home computers. "Bad news doesn't sell," he says.

Market research's happy-news tendency serves an important function, say its practitioners. Without a willing suspension of disbelief, they claim, bold ventures might never happen. "If people looked realistically at new technologies at their inception, they would never make the investment," says Les Cowan, senior industry analyst at Rothchild Consultants. "Self-delusion" is necessary, argues Cowan, before embarking on any long, risky enterprise. "It's the same as in a war," he says. "You can't win unless every soldier has convinced himself he's not going to be the one killed."

Market forecasts often assume that existing conditions will persist into the future, which is like trying to drive by looking in the rear-view mirror. "It's dangerous to assume present trends will continue," says Meg Lewis, vice president of Future Computing. Such an assumption has afflicted several firms trying to project the personal-computer market, Future Computing prominent among them. From 1978 to 1983, personal-computer sales grew rapidly, as pioneering users absorbed the first wave of products. But after these early adopters had bought their fill, the industry slumped. The 1985 slowdown caused "lots of finger-pointing," recalls Lewis; manufacturers accused forecasters of misleading them about the extent of demand.

Crystal-ball gazers get blindsided with such regularity that it's a wonder anyone still pays attention to them. For example, in 1983 Dataquest predicted that the market for computer-aided design (CAD) systems would rise to $6.3 billion by 1986. The market actually hit more than $7.3 billion. Why the underestimate? "We didn't expect personal computers to become part of the CAD market," says Beth Tucker Romig, associate director of Dataquest's industrial-automation research group. The firm's 1983 prediction accounted only for expected sales of minicomputer-based CAD; personal computers were relatively new on the scene.

There have been other cases of clouded vision. In the early to mid-1980s, most pundits forecast boom times for satellite communications. The star technology was going to be Ku-band equipment—compact receivers operating at higher frequencies than existing C-band systems. "We predicted a rapid rise of the Ku-band market," says analyst Barry Bartlett at Market Intelligence Research. But the satellite-communications business has grown

ILLUSTRATIONS BY ROGER ROTH

more slowly than expected, in part because of the loss of the space shuttle Challenger. Market researchers can hardly be held responsible for not anticipating that disaster, which delayed new satellite launches.

Market researchers should, however, have foreseen the rampant spread of fiber-optic telecommunication lines, which provide much the same service as satellites. Starting in 1983 and 1984, the major long-distance telephone companies (MCI, AT&T, and GTE Sprint) laid a nationwide web of fiber and stole business from satellites.

Overlooking the competition is a common flaw of market research. Companies developing a new technology tend to become its boosters, unrealistically ignoring the improvements still possible in existing products. "People underestimate the life still left in old technologies," says Finley of Dataquest.

Such parochialism led to embarrassingly inaccurate projections for sales of optical-memory disks, which hold vast quantities of information—as much as a few billion digital bits. Expecting these disks to steal market share from magnetic disks, a number of research firms, including Rothchild Consultants and Business Communications, predicted in 1983 and 1984 that optical data-storage systems would produce annual revenues of several hundred million dollars by 1990.

Alas, the market has come nowhere near that level. One reason is that it took longer than expected to bring optical disks from lab to market. But more importantly, magnetic disks underwent continual improvement. Floppy disks, which once held only 360 kilobytes, today can store a megabyte or more, and magnetic hard disks are pushing toward 100 megabytes.

Particular success was projected for compact disc read-only memories (CD-ROMs). These cousins of audio compact-disc players were expected to become essential attachments to personal computers. In 1986, several firms estimated that as many as one million CD-ROM drives would be in use by the end of the decade. But industry insiders say only about 50,000 CD-ROM drives have so far been built.

The best forecasting looks sideways as well as ahead. "The things that traumatize business come from the outside," says John Varston, president of Technology Futures. Forecasters often don't see a new technology's most profound implications, he says, because "they're looking in the wrong places." Varston points out that one of the century's pivotal inventions—the transistor—underwhelmed early analysts, who saw it only as a replacement for vacuum tubes in radio receivers.

One of the more notable success stories of market research illustrates the value of being aware of activity in other fields. In 1981, Dataquest correctly predicted that low-cost laser printers would arrive by 1985 or 1986, an assumption based on an analyst's knowledge of Japan's photocopier industry. The analyst saw that Canon had developed a copying system based on a cheap, compact semiconductor laser; until that time, bulky and expensive gas-tube lasers were used. Dataquest correctly noted that the same laser system could serve as a printer engine.

Such a direct hit is rare among long-term predictions. Indeed, some researchers admit that they include long-range forecasts in their reports primarily to assure press coverage. Such forecasts are especially suspect for technologies not yet on the market. Still, research firms persist in publishing predictions on superconductors, neural-network computers, and other technologies with no commercial history. It's "crazy" to make forecasts on embryonic technologies, says Selvin of Electronic Trend. "We put in forecast numbers to get people's attention," admits Portia Isaacson, founder of Future Computing and now president of Future Think. "Everybody knows we're pulling numbers out of a hat."

In general, the better reports come from companies with full-time staff researchers: Dataquest, International Data Corp., and Arthur D. Little, for example. Spottier quality comes from organizations that rely heavily on free-lance contributions, such as Frost & Sullivan and Business Communications. Some free-lance researchers have a deep understanding of the industry they cover, but others do not, and their reports lean on information drawn from back issues of trade magazines. Worse, some free-lancers recycle the sales forecasts of competing number-mongers. "Sometimes market-research firms watch each other too closely," concedes Bartlett of Market Intelligence Research.

In one frequently cited example, a 1978 free-lanced study for Frost & Sullivan completely missed the impending

MARKET MISPREDICTIONS

INDUSTRIAL ROBOTS

Predictions:

$828 million in 1987 (Venture Development)
$5 billion in 1992 (International Resource Development)
$4 billion in 1995 (Predicosts)

1987 sales: $300 million, down from $440 in 1986

HOME ROBOTS

Predictions:

$1-2 billion in 1990 (Future Computing)

1987 sales: 0

CHEAP HOME COMPUTERS

(Under-$500 units for games, education)

Predictions:

$835 million in 1986 (International Data Corp.)
$2.3 billion in 1995 (Electronic Trend Publications)
$4.4 billion in 1987 (Future Computing)

1987 sales: 0

MONOCLONAL ANTIBODIES

Predictions:

$5 billion in 1992 (Fritzsche, Pombianchi & Associates)

1987 sales: $600 million

VIDEOTEX

Predictions:

$7 billion in 1987 (Creative Strategies International)
$12-15 billion in 1990 (Newsletter publisher Gary Arlen)

1987 sales: $113 million

VIDEOCONFERENCING

Predictions:

$600 million in 1992 (International Resource Development)
$1.3 billion in 1990 (Eastern Management Group)

1987 sales: $100 million

SPEECH RECOGNITION

Predictions:

$1 billion in 1990 (Probe Research)
$4 billion in 1992 (International Resource Development)

1987 sales: $50 million

CD-ROM PLAYERS

Predictions:

$550 million in 1990 (Communications Publishing Group)

1987 sales: $16 million

1987 FIGURES: HIGH TECHNOLOGY BUSINESS RESEARCH

SOME MARKET-RESEARCH FIRMS

Arthur D. Little 17 Acorn Park Cambridge, MA 02140 (617) 864-5770	Business Communications 25 Van Zant St. Norwalk, CT 06855 (203) 853-4266	DataPro Research 1221 Ave. of the Americas New York, NY 10020 (212) 512-3851	Dataquest 1290 Ridder Park Dr. San Jose, CA 95131 (408) 437-8000
Electronic Trend Pub. 12930 Saratoga Ave. Saratoga, CA 95070 (408) 996-7416	Find/SVP 625 Ave. of the Americas New York, NY 10011 (212) 645-4500	Freedonia Group 2940 Noble Road Cleveland, OH 44121 (216) 381-6100	Fritzsche, Pambianchi & Assoc. 3461 Route 223 East Somerville, NJ 08876 (201) 231-9634
Frost & Sullivan 106 Fulton St. New York, NY 10038 (212) 233-1080	Gartner Group Box 10212 Stamford, CT 06904 (203) 967-6848	Input 1280 Villa St. Mtn. View, CA 94041 (415) 961-3300	International Data 5 Speen St. Framingham, MA 01701 (508) 872-8200
Intl. Resource Devel. 21 Locust Ave. New Canaan, CT 06840 (203) 866-7800	KMI Americos Cup Ave. Newport, RI 02840 (401) 849-6771	Mkt. Intelligence Research 2525 Charleston Rd. Mountain View, CA 94043 (415) 961-9000	Predicasts 11001 Cedar Ave. Cleveland, OH 44106 (216) 795-3000
Prognos 1852 McCraren Rd. Highland Park, IL 60035 (312) 831-0136	Rothchild Consultants 256 Laguna Honda Blvd. San Francisco, CA 94116 (415) 681-3700	Strategic Analysis Box 3485, R.D. 3 Reading, PA 19606 (215) 779-9080	Technical Insights 32 N. Deon St. Englewood, NJ 07631 (201) 568-4744
Technology Res. Group 2 Park Plaza Boston, MA 02116 (617) 482-4200	Technology Futures 6034 W. Courtyard Dr. Austin, TX 78730 (512) 343-6468	Venture Economics 16 Laurel Ave. Wellesley Hills, MA 02181 (617) 237-3111	Yankee Group 200 Portland St. Boston, MA 02114 (617) 367-1000

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH

explosion of the fiber-optic communications business. The company predicted the fiber-optics market would grow from that year's level of about $10 million to $60 million in 1987, and to $180 million in 1992. In reality, fiber optics has become a $700-million business.

Free-lancers do offer some benefits, however. Outside consultants "have no axe to grind," says Frost & Sullivan spokeswoman Susan Call. Moreover, adds Selvin of Electronic Trend Publications, the use of free-lancers gives a research firm a wider range of expertise than would be practical to have on staff.

Find/SVP, an organization that sells its own as well as other firms' market-research reports, has a unique perspective on uneven quality. Acting as a clearinghouse, Find/SVP refuses to include in its catalog about one in five published research reports, says marketing director Michael Shore.

Third-rate reports typically "get all their information from the Commerce Department or from other publications," says Shore, and their company descriptions offer little more than the Dun & Bradstreet writeup.

For the most part, you get what you pay for. Off-the-shelf reports—as opposed to studies done for a limited number of clients—typically cost $1,000 to $3,000. Money buys research time, and research time usually results in better accuracy. "A $600 report won't have much beyond published data," says Robert Butler, president of Business Communications, whereas $3,000 buys two months of telephone interviewing.

High-cost reports can nevertheless offer foolish predictions, as was the case with estimates in the early 1980s of industrial-robot market growth. The reports ignored the obvious: that U.S. manufacturing—i.e., the robot market—was moving overseas in search of cheap labor. In another case, some gushing CAD forecasts predicted straight-line 50 percent annual growth, until CAD systems would outnumber all architects and engineers, the users of such systems. Most research firms "are led by wishful thinking," says Texas Instruments vice president Eugene W. Helms, who manages corporate strategic planning.

Corporate strategy makers say they don't rely greatly on published market forecasts. General Electric, for example, uses third-party research only to supplement its own strategic analysis, says spokesman George Jameson. At Texas Instruments, outside research is "just one of many pieces of information," says Helms. "It's certainly not the decisive element."

Even as they promote their far-sightedness, market researchers warn against relying on that vision—especially if it proves wrong. A company or investor would be "crazy to use a market-research report to decide where to commit its resources," says Business Communications' Butler. Kenneth Bosomworth, president of International Resource Development, says the numbers his firm or others put out should be used only as rough guides. Anybody who started, say, a robotics company based on published market-research reports "is a fool," says Bosomworth.

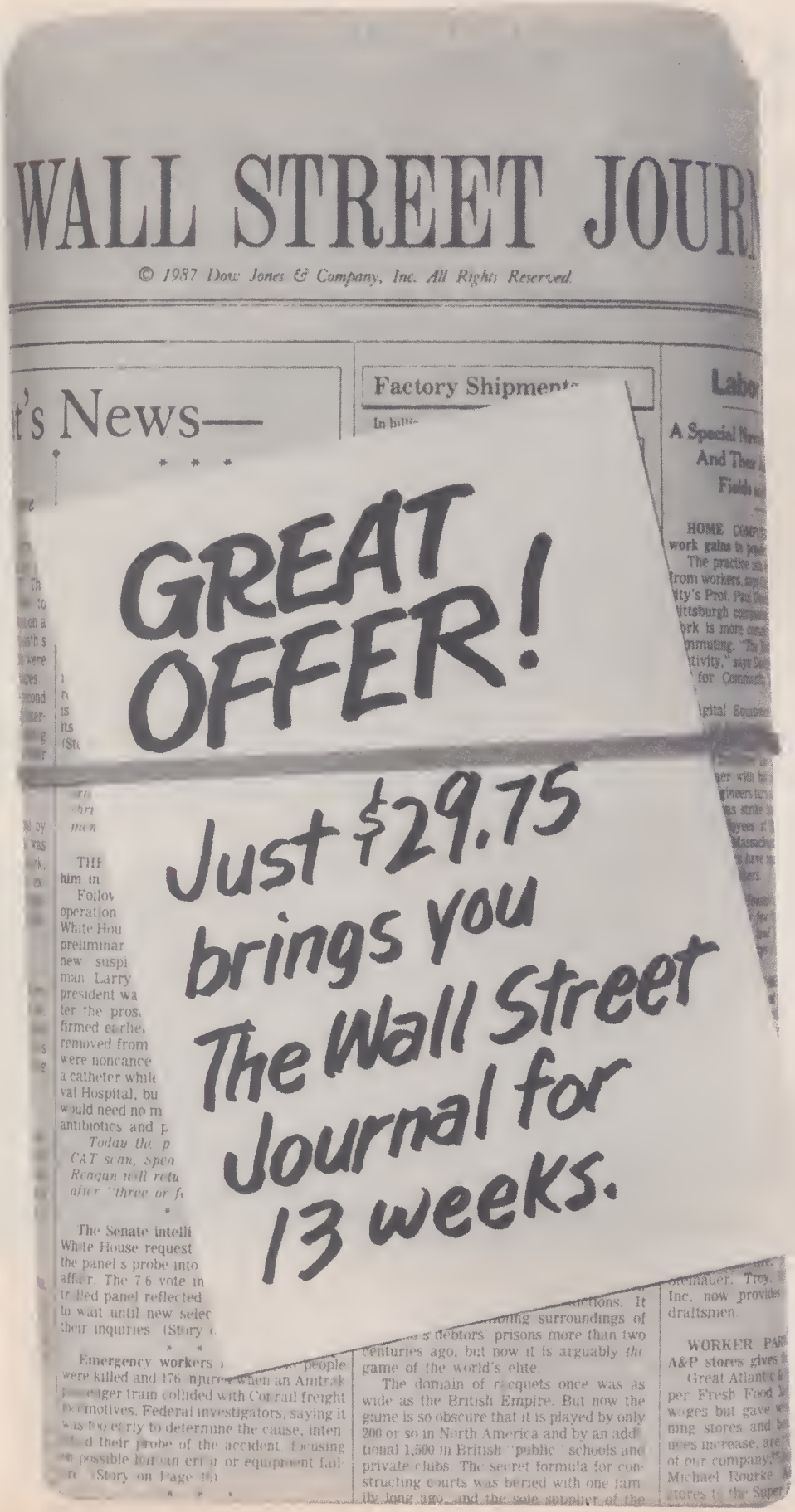
These firms may overestimate their customers' sophistication. Retail brokerage houses, which sell stocks to small investors, often accept official-looking market forecasts uncritically. Venture capitalists have been burned repeatedly in recent years, swallowing predictions for robotics, machine vision, and personal computers. Of all these, technology producers have arguably been the biggest victims. Overly optimistic reports of coming growth in the home-computer market were one reason Texas Instruments cut the price of its home computer to below production costs in the early 1980s. The company hoped a price tag of less than $100 would fuel enough demand to bring production costs below that cut-rate level. The demand never materialized, and Texas Instruments took a bath.

The company was similarly burned by rosy predictions about electronic-speech products. In 1980, International Resource Development figured that annual sales of speech-synthesis systems would mushroom from $25 million to $1 billion by mid-decade. "We saw such huge potential," says president Bosomworth. The artificial-speech hardware market today reaps revenues of only about $50 million.

Market-research companies get defensive when challenged on their past accuracy. Electronic Trend's Selvin calls such queries a "waste of time," because any forecast is grounded in the knowledge available at the time. "We're not in the prophecy business," says analyst Barry Bartlett of Market Intelligence Research. Shrugs Bosomworth of International Resource Development, "Sometimes we hit the nail on the head, other times we bang the hammer on our thumb. It's absurd to say that we can predict the future."

Few in the Twilight Zone of market forecasting would disagree. ■

Editorial assistant Jennifer Christensen contributed to this article.



Subscribe now to The Wall Street Journal and every business day you'll get the facts and ideas which could make you—and your company—more successful.

We'll tell you the products that are selling, where new markets are, the executives on the rise, and what your competitors are up to. You'll find out how companies like yours and people like yourself are solving problems and developing management techniques that work.

Manage your personal finances better with The Journal.

Every issue contains the column, *Your Money Matters,* with helpful information on every aspect of personal finance—stocks, bonds, money markets, tax shelters, commodities, IRS regulations, and more.

Great subscription offer.

If your goal is greater success for your company and yourself, The Wall Street Journal can get you off to a running start every business day. Subscribe now and take advantage of The Journal's great offer—13 weeks for just $29.75. Complete and mail the coupon today!

THE WALL STREET JOURNAL
228 East 45th Street
Suite 1515
New York, New York 10017

- ☐ Send me 13 weeks of The Journal for $29.75.
- ☐ I prefer a six-month subscription (26 weeks) for $59.50.
- ☐ Check enclosed *(payable to The Wall Street Journal).*
- ☐ Bill me.
- ☐ Please charge my: ☐ American Express ☐ Diners Club ☐ MC ☐ VISA

CARD #

EXPIRES

SIGNATURE

NAME (please print)

ADDRESS

SUITE/APT.

CITY

STATE ZIP 35HG

Limited time offer—good in continental U.S. only.

The Battle for the Broker's Desk

Information-service companies sharpen their strategies for supplying financial data

BY HENRY FERSKO-WEISS

THE FINANCIAL-services industry is going through a major upheaval. As international markets become increasingly volatile and trading volumes expand, brokers and traders need additional data just to keep up, and information-service providers are locked in a battle to give it to them.

The weapons include new microcomputers and workstations, better analytical software, a decentralization of brokerage computer systems, and not-so-subtle psychological gamesmanship.

For companies that provide financial information, this is a fight for the future. The market positions of the first- and second-place players in the equities-information market—Quotron Systems and Automatic Data Processing (ADP)—are almost certain to be reversed. International heavyweight Reuters Holdings PLC has finally burst the contractual dam that kept it out of the U.S. market. As the top contenders struggle, smaller players such as PC Quote, Bridge Information Systems, and Knight-Ridder Financial Information will take advantage of the confusion to launch attacks on market niches.

The fallout of this battle will give brokers and traders faster access to more data, as well as new processing tools such as portfolio-management software, risk-management packages, and trading models. These tools give brokerage houses a way to lure top brokers, boost business, and give clients more focused help with investments.

The hottest systems use the most advanced equipment—microcomputers and workstations from companies such as IBM, Digital Equipment Corp., Hewlett-Packard, Sun Microsystems Inc., and Apollo Computer Inc. These machines offer superior speed and processing capabilities by using Intel 80386 and Motorola 68020 processing chips, and recently enjoyed a substantial drop in prices—partly due to economies of scale provided by opening up the financial market. These factors alone don't justify the purchase of hardware that can cost anywhere from $5,000 to more than $100,000 per box, but the growing complexity and competitiveness of the financial markets do.

"With the advent of 24-hour trading on global markets, institutions have to link their positions worldwide to allocate capital and determine risk," says Richard Caplis, director of the information-systems group at Coopers & Lybrand Management Consulting Services, a unit of the Big Eight accounting firm. "Positions are very large, the

PHOTO: JEFFREY COOLIDGE/PROPS: THE TOY SOLDIER

markets have become complicated, and changes come rapidly. Program trading [now mostly halted by securities firms], dreamed up by the people who do arbitrage between cash and options markets, was the beginning of the problem." The market competitiveness can be traced to the tremendous influx of investment dollars during the bull market of 1982 to 1987. As the market began to peak, trading activity hit a new level of volatility and stayed there.

To cope with these conditions, financial institutions spent $1.22 billion on information services in 1987, according to market researcher Link Resources Corp. Link predicts that the financial-information business will grow to $3.02 billion by 1991, topping credit and travel information to become the largest segment of the information industry.

The key information in this deluge of data are price quotations on stocks, bonds, foreign exchange, commodities, and other financial instruments. In the past, brokers got price quotes from "dumb" terminals connected by leased lines to the mainframe computer of a quotation provider. Today the terminals on a broker's desk are at least semi-intelligent, with some computing power of their own, and an increasing number are advanced workstations that pack more power than did the mainframes of a decade ago.

As terminals improved, so did the delivery path for information. In addition to standard leased telephone lines, today's systems use 56-kilobit land lines, satellites, and unused parts of the FM-radio and TV spectrums (see "Delivering the Data," p. 33).

Presentation has also improved. Instead of a stream of hard-to-decipher digits, the new systems provide "multi-window displays that might show different market data feeds in colors—let's say green for stocks and blue for foreign exchange," says Craig Symons, vice president at the Gartner Group, a market-research firm. "Some of the price information may also be poured through an analytical program that then presents it in graphic form. These visual aids increase the immediate comprehension of the numbers."

Brokers equipped with workstations get more than price information. They can identify prospective clients through multi-layered database searches and analyze a client's position with risk management and portfolio management software—some with built-in artificial intelligence techniques. They can also communicate with each other via electronic mail. Most important, workstations let brokers use all of these functions at the same time.

Quotron now controls 60 percent of this world of flitting equities numbers and smart applications, according to George Sacerdote, a vice president at market-research firm Arthur D. Little. ADP is second with about 30 percent. The host of other providers split the remaining 10 percent.

ADP crashed the stock-quotation marketplace by buying Bunker Ramo in February 1986, and has kept pushing

ever since. ADP originally provided back-office computing systems to many financial companies, so it understood the benefits of integrating record-keeping with quotation and analytical functions. "ADP was very much aware of the need to increase the technological expertise used in information delivery," says Jim Settel, senior vice president of product development at Prudential-Bache Securities. "They made it easier for us to recognize the potential."

Prudential-Bache's system offers a good example of the benefits of financial-information products. ADP helped the company build an integrated system using Convergent Technologies minicomputers as branch-office processors and microcomputers as the brokers' window on the markets. The system combined data feeds from ADP, off-the-shelf software such as Lotus' 1-2-3 spreadsheet, and proprietary programs written by Prudential-Bache programmers. The new system lets brokers calculate bond yields to maturity by pressing a few keys, send personalized form letters to clients, and follow the New York Stock Exchange and bond markets. It was dubbed Boss 1, for branch-office support system. Three Prudential-Bache offices have already moved on to Boss 2, a distributed processing system that maintains branch-office data locally on the Convergent Technologies minicomputers.

"Brokers can create client or prospect profiles that include the data they think is important, such as income, objectives, product interests, even hobbies," says Settel. "There's also an electronic broker-book program that records every purchase, sale, profit, and loss, and maintains that information locally for 18 months. A query function lets brokers search for clients that fit certain criteria. For example, a broker could pull the records for all clients in a zip code who have municipal bonds in their portfolio, make more than $100,000, have a portfolio yield of less than 5 percent, and like to play golf. With this list, a broker could write a letter alerting the group to a special seminar on a new investment opportunity being held at the local golf club. Before this system, it would have been impossible to get so specific on a client search, and the information you could get would take much longer to stream

THE PRICE-QUOTATION LEADERS

COMPANY	WORLDWIDE TERMINALS	1987 REVENUE	1987 GROWTH	COMMENTS
Reuters Holdings Reuters North America 1700 Broadway New York, NY 10019 (212) 603-3300	145,000	$1.6 billion* (Reuters Holdings) $326 million* (Reuters North America)	39.6 percent 32.7 percent	Holds 80 percent of the foreign-exchange information market, forming the backbone of this international market. Reuters earns about 56 percent of its revenues from foreign-exchange, but also offers quotation and information services on fixed-income securities, commodities, and stocks. Now trying to penetrate the U.S. market for domestic stock data with its Equities 2000 system, which delivers real-time quotes on 100,000 instruments from 137 exchanges. Reuters' advanced technology, coupled with its enormous reach and financial power, should make it a third major force in that market.
Quotron Systems 5454 Beethaven St. Los Angeles, CA 90066 (213) 827-4600	95,000	Not available (subsidiary of Citicorp since 1986)	Not available	Holds 60 percent of the domestic stock quotation business, but is on the verge of losing its leadership to ADP. Quotron provides real-time price quotes from exchanges around the world, covering stocks, options, bonds, mutual funds, and commodities. The company's most advanced service, the Quotron 1000, uses minicomputers to serve the entire branch office and semi-intelligent workstations on the broker's desk to offer real-time price quotes, analytical programs, financial databases, and messaging facilities.
Telerate 1 World Trade Center New York, NY 10048 (212) 938-5200	67,000	$336 million	44.5 percent	Dominates the fixed-income information marketplace, offering real-time quotes on U.S. government and mortgage-backed securities. Telerate also covers worldwide money markets, foreign exchange, financial futures, and precious metals. In October 1987, it acquired Canada's CMQ Communications to try and crack the equities-information market.
Automatic Data Processing 1 ADP Blvd. Roseland, NJ 07068 (201) 994-5000	65,000	$1.4 billion	15 percent	In addition to real-time price quotes on stocks, bonds, commodities, and foreign exchange, ADP offers Videcom, a graphic technical-analysis service. Agreements with Merrill Lynch and Shearson to replace Quotron terminals with IBM PS/2s will make ADP the top domestic equities-information provider. ADP's strength in back-office systems, coupled with advanced front-office technology, should continue to boost its market share.
Knight-Ridder 1 Herald Plaza Miami, FL 33132 (305) 376-3838	19,750	$2.1 billion (corporate) $99.6 million (Business Information Services division)	8.5 percent 11.6 percent	Dominates the commodities-quotes and news market with its CNS Data Quote service. Recently challenged Telerate in the fixed-income securities area with its Money Center service, which offers quotes on fixed-income, mortgage-backed, and government securities, plus fundamental news. Another service, called Trade Center, provides charts and analysis for all kinds of securities. Knight-Ridder has also set its sights on the fixed-income arena.
PC Quote 401 S. LaSalle St. Chicago, IL 60604 (312) 786-5400	Not applicable	$6,086,435	79 percent	Offers equity-quote information over a network of personal computers. This approach offers significant cost savings, and the company claims it has 1,200 customer locations. PC Quote lost $558,188 in 1987, but posted its first profitable quarter this year.
Bridge Information Systems 10050 Manchester Rd. St. Louis, MO 63122 (314) 821-5660	Not available	Not available	Not available	Provides last sale and historical information on more than 60,000 financial instruments. The system also offers computerized portfolio accounting packages, a brokerage office support system, electronic mail, and real-time news. Bridge, a private company, is noted for its use of graphics to make data clearer.
Data Broadcasting 8300 Old Courthouse Rd. Vienna, VA 22180 (703) 790-3570	1,600	Not available	Not available	Delivers price information and financial news over an unused part of a TV signal to individual investors and brokerage firms equipped with special decoders, TV tuners, and personal computers. Owned by Financial News Network, which is controlled by Infotechnology Corp., the company that publishes HIGH TECHNOLOGY BUSINESS.

* Based on an exchange rate of $1.89 to the pound on Dec. 31, 1987.

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH/INFORMATION INDUSTRY BULLETIN

center and sends

nation vendors use
iers, unused parts
stations, or the ver-
ne television signal
vision station to dis-
ansmissions, which
ations or by FM or
computer informa-

vely slow, but inex-
r price quotes to in-
ernate distribution
the same informa-
ecause special land

al-time price quote
on is used by a bro-
ccount representa-
, portfolio-manage-
graphics come into
ional investors get
t makes the differ-
rading decisions.

usiness from regional
s. Regional successes
ards & Sons Inc. of St.
of Michigan Capital
On a larger scale, Quo-
cess of converting all
er's offices.
approved its system
ck Monday, in spite of
essimism and the talk
rokerage firms. Like
her major brokerage
ebber's management
information systems
staying competitive;
slowdown in comput-

a very extensive two-
of all the systems be-
Quotron," says John
r of consumer market
systems at PaineWebber's New York headquarters. "We needed to upgrade our system because the branch offices had reached their capacity limits." One of the side benefits of upgrading the information system, according to Murphy, is that "it shows we are making a significant commitment to technology. This makes a difference in attracting and retaining brokers who have similar capabilities in other firms."

pressed," says Settel. Both companies signed contracts with ADP to replace their present Quotron systems, a major blow to the market leader. Each of the new systems will use about 20,000 IBM PS/2 computers as terminals, a market-share shift of more than 50 points.

But George Levine, Quotron's executive vice president of customer relations and strategic marketing, doesn't accept the Merrill Lynch and Shearson

the same features: screen windows, multiple processing, a mix of client and market information, word processing, spreadsheets, portfolio management, and decentralized operation. In the future, the system will support workstations.

Quotron is converting customers with older technology to the Q-1000 and

ever since. ADP o
back-office computin
financial companies
the benefits of integ
ing with quotation a
tions. "ADP was ve
the need to increas
expertise used in inf
says Jim Settel, seni
product developm
Bache Securities. "I
for us to recognize t

Prudential-Bache'
good example of th
cial-information pro
the company build
tem using Conver
minicomputers as br
sors and microcom
kers' window on the

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 68 BOULDER, CO

POSTAGE WILL BE PAID BY ADDRESSEE:

High Technology Business
P.O. Box 51488
Boulder, Colorado 80321-1488

COMPANY				
Reuters Holdings Reuters North America 1700 Broadway New York, NY 10019 (212) 603-3300				
Quotron Systems 5454 Beethoven St. Los Angeles, CA 90066 (213) 827-4600				
Telerate 1 World Trade Center New York, NY 10048 (212) 938-5200				
Automatic Data Processin 1 ADP Blvd. Roseland, NJ 07068 (201) 994-5000				
Knight-Ridder 1 Herald Plaza Miami, FL 33132 (305) 376-3838				
PC Quote 401 S. LaSalle St. Chicago, IL 60604 (312) 786-5400				
Bridge Information Systems 10050 Manchester Rd. St. Louis, MO 53122 (314) 821-5660	Not available	Not available	Not available	Provides last sale and historical information on more than 60,000 financial instruments. The system also offers computerized portfolio accounting packages, a brokerage office support system, electronic mail, and real-time news. Bridge, a private company, is noted for its use of graphics to make data clearer.
Data Broadcasting 8300 Old Courthouse Rd. Vienna, VA 22180 (703) 790-3570	1,600	Not available	Not available	Delivers price information and financial news over an unused part of a TV signal to individual investors and brokerage firms equipped with special decoders, TV tuners, and personal computers. Owned by Financial News Network, which is controlled by Infotechnology Corp., the company that publishes HIGH TECHNOLOGY BUSINESS.

* Based on an exchange rate of $1.89 to the pound on Dec. 31, 1987.

SOURCE: HIGH TECHNOLOGY BUSINESS RESEARCH/INFORMATION INDUSTRY BULLETIN

DELIVERING THE DATA

The real-time price quotes brokers see flashing and changing on their desktop screens may come from any of nearly 140 exchanges around the world. The exchanges supply data feeds from their computers to the computers of quotation companies, such as Reuters or Quotron, right at the exchange. The feeds are also provided to such organizations as Standard & Poor's, Monchik Weber, and Commodity Quotations Inc., which sell the "pure" data streams to companies that place the terminals on brokers desks. The information companies then send streams of securities prices to regional computer centers via high-speed modems and leased telephone lines.

From there, companies use a variety of methods to deliver the information to brokers. The most common approach uses special phone lines to carry price quotes directly from the regional computer center to the broker's desktop terminal. Today, the fastest phone lines handle 56,000 data bits per second, so in some cases quotation information can reach brokers in a fraction of a second.

More sophisticated systems speed the process for large blocks of data by using minicomputers at the brokerage office to collect commonly requested price quotes. The minicomputers then transfer the blocks of data to the brokers' workstations or personal computers through a local-area network. The quote vendor maintains less-requested information at the regional computer center and sends them out when needed.

Instead of phone lines, some information vendors use satellite communications, FM subcarriers, unused parts of the spectrum allocated to FM radio stations, or the vertical blanking interval (a portion of the television signal not normally seen by viewers) of a television station to disseminate price information. These transmissions, which are received by small satellite earth stations or by FM or TV antennas, are converted to digital computer information by special modems.

FM subcarrier transmission is relatively slow, but inexpensive, and is primarily used to deliver price quotes to individuals and small offices. These alternate distribution methods make sense for distributing the same information to a large number of recipients, because special land lines are not needed.

The most important part of any real-time price quote system, however, is the way information is used by a brokerage firm, its traders, and retail account representatives. This is where analytical software, portfolio-management programs, and high-resolution graphics come into play. All brokerage firms and institutional investors get pretty much the same raw data. What makes the difference is how they use the data to make trading decisions.

downline from our central mainframe."

The brokers at Prudential-Bache are so happy they are experiencing "techno-rapture," in Settel's words. "They can do things now they didn't dream of," he says. "Plus it reduced the professional overload."

"Workstations and proprietary software are becoming strategic weapons," says Mike Frank, group manager for the financial and commercial markets at Apollo Computer. "Once one firm sees the advantage of such systems, all the others jump on the bandwagon. Computers beget computers."

Merrill Lynch Pierce Fenner & Smith Inc. and Shearson Lehman Hutton Inc. have jumped after Prudential-Bache. Representatives from both firms visited Prudential-Bache to check out the new approach. "They were very impressed," says Settel. Both companies signed contracts with ADP to replace their present Quotron systems, a major blow to the market leader. Each of the new systems will use about 20,000 IBM PS/2 computers as terminals, a market-share shift of more than 50 points.

But George Levine, Quotron's executive vice president of customer relations and strategic marketing, doesn't accept the Merrill Lynch and Shearson deals as *faits accomplis*. "We are far from acquiescing," he says. "We continue to develop tools that would make replacing us more difficult. It's a moving target, and ADP has already missed some tentative delivery dates."

Still, Quotron has suffered for its emphasis on a dedicated system of semi-intelligent terminals rather than an open architecture that permits use of third-party personal computers or workstations. The dedicated system prevented brokers from using popular programs such as 1-2-3. Also, the terminals Quotron pushed lacked the sharp images and color available on personal computers and workstations.

The company is trying to fight back, and Levine insists that its new Q-1000 system is as capable as ADP's system, and as open. The Q-1000 has many of the same features: screen windows, multiple processing, a mix of client and market information, word processing, spreadsheets, portfolio management, and decentralized operation. In the future, the system will support workstations.

Quotron is converting customers with older technology to the Q-1000 and trying to attract business from regional brokerage houses. Regional successes include A.G. Edwards & Sons Inc. of St. Louis, and First of Michigan Capital Corp. of Detroit. On a larger scale, Quotron is in the process of converting all 285 of PaineWebber's offices.

PaineWebber approved its system shortly after Black Monday, in spite of general market pessimism and the talk of downsizing brokerage firms. Like managers at other major brokerage houses, PaineWebber's management decided that new information systems are essential to staying competitive; there has been no slowdown in computer purchases.

"We conducted a very extensive two-year evaluation of all the systems before we chose Quotron," says John Murphy, manager of consumer market systems at PaineWebber's New York headquarters. "We needed to upgrade our system because the branch offices had reached their capacity limits." One of the side benefits of upgrading the information system, according to Murphy, is that "it shows we are making a significant commitment to technology. This makes a difference in attracting and retaining brokers who have similar capabilities in other firms."

MOVING THE MARKETS INTO THE FUTURE

In an age when information moves at the speed of light and computers process a hundred million instructions a second, financial traders still close deals with frenzied shouts and slips of paper. The New York Stock Exchange (NYSE) and others have been studying the idea of fully electronic markets for years, but automation remains incomplete because of the technological complexity of the task and the natural inertia of large, conservative institutions. Many floor brokers also resist the idea, because they are intimidated by computers, afraid for their jobs, or enamored of the clubbiness of the trading floor.

Despite these obstacles, automation has come to the routing of buy and sell orders on the NYSE and other exchanges, and the gathering of bids and offers on the London Stock Exchange. Reuter's Instinet service lets buyers and sellers negotiate using computer monitors, and Transvik Inc., a New York subsidiary of a Swedish merchant banking company, has developed an electronic trading system that could be used to totally automate a market. There is even one fully automated exchange, the Bermuda-based International Futures Exchange (Intex). This exchange is attempting to develop joint ventures with other exchanges that are seeking to automate and want to use Intex software, which has a proven track record of handling exchange requirements.

The NYSE's SuperDot system, created in 1984, enables member firms to send orders electronically to specialist trading posts on the exchange floor. This system bypasses floor brokers, who used to have to walk across the floor to deliver the order. When a transaction is completed, SuperDot picks up again, electronically reporting back to the member firm and submitting the order for comparison. But the process still requires a specialist to manually work the order on the floor. In essence, the computer has replaced the telephone or telex and the floor broker on the front end, and a keypunch operator on the back end. The actual trader remains.

SuperDot now carries 70 percent of NYSE orders. But this represents only 30 percent of the exchange's volume, because SuperDot is prohibited from handling big block trades. For example, SuperDot is limited to pre-opening market orders of 5,099 shares, and no more than 30,099 shares while the market is open.

Instinet, a service from Reuters Holdings, comes one step closer to creating a completely electronic market, letting buyers and sellers negotiate their transactions through computer monitors. When an order is posted on the network, an interested party can accept it or ask the seller to do better. After two Instinet subscribers agree on a transaction for a listed stock, it's transmitted to an Instinet floor representative, who takes the deal to a specialist for execution. Instinet trades of unlisted securities do not have to go through an exchange floor. According to a Reuters spokesman, most of the 1.44 billion shares traded on Instinet last year represented institutional trading on unlisted securities.

Even before Reuters bought Instinet in May 1987, it offered a similar trading network for foreign exchange, bonds, and bullion. Begun in 1981, the Reuters Monitor Dealing Service "replaced telephone and telex communi-

Aside from upgrading its technical capabilities, Quotron faces another challenge. Citicorp bought Quotron in November 1986, and brokerage firms often compete with Citicorp subsidiaries such as CitiBank. Many firms say they don't want to buy information from a rival.

While the two dominant players slug it out, Reuters is using its international strength to join the brawl. Last May, Reuters, the largest information provider worldwide, bought Instinet, an electronic trade-posting system that covers equities. Reuters has also developed a sophisticated digital network to deliver its information. One of the first offerings on the fast, 56-kilobit-per-second Integrated Digital Network (IDN) is Equities 2000, a worldwide quote system that offers real-time prices on more than 100,000 financial instruments traded on more than 137 exchanges.

Equities 2000 is Reuters' first foray into the U.S. equities-information market. An agreement with ADP kept Reuters out of the business until 1986, but the company is now trying to make up for lost time. Besides its acquisition of Instinet, Reuters bought several other companies in 1986 and 1987. One of these, Reveal Software Inc. of Roslyn, N.Y., has a package that helps brokers manage their clients' portfolios more efficiently. Another recent purchase, Toronto-based I.P. Sharp, markets 150 historical on-line databases, some of which carry financial and economic data useful to traders. In 1985, Reuters acquired Rich Inc. of Chicago, a manufacturer of complete trading-room systems. Rich gives Reuters a foot in the door at some of the largest equities-trading firms.

"We have two factors that will help us achieve an increasingly satisfactory market share," says Patrick Mannix, international technical manager for Reuters. "The first is our comprehensive coverage of international equities, which is of increasing interest to brokers. Second, we have a very good platform for trading in large institutions." Reuters got a big break last year when Prudential-Bache bought more than 1,000 Equities 2000 terminals for installation around the world—250 of them went into the company's New York headquarters.

Although Reuters hopes to become a major player in equities information, it does not see itself taking customers away from ADP and Quotron, says Mannix. "There is room for us to expand with the marketplace," he says. But A.D. Little's Sacerdote thinks that Reuters may have more dramatic long-term ambitions. Reuters "is spending a lot of money to develop a U.S. position," he observes. "They clearly have designs on the market."

In the meantime, Reuters holds an impenetrable position in the foreign-exchange market, just as competitor Telerate dominates bonds and other fixed-income securities. These markets are the special terrain of investment traders who work large blocks of instruments for their firms or for big ac-

cations between places like Riyadh and Paris," says the spokesman. "On-line systems are much more efficient."

The London Stock Exchange's "Big Bang" on Oct. 27, 1986, set off the automated gathering of bids and offers. The Bang created a whole new trading environment. Instead of brokers wandering the floor in search of bids and offers—the London Exchange had no set locations for trading a particular stock—brokers now sit in their offices and communicate electronically. "The trading floor is still open, but nobody goes there anymore," says David Rosensaft, president of Transvik. "It would make a nice discotheque or roller-skating rink."

Even though the London stock market has automated part of the trading process, dealers make trades over the phone, not by computer. The exchange intends to become fully electronic, but hasn't yet decided how to do it.

Transvik claims to have an answer to the technological part of the electronic-exchange conundrum. The company's turnkey system runs trading software on an Ethernet local-area network supported by Digital Equipment Corp.'s VAX minicomputers and 32-bit desktop workstations. In essence, the network becomes the trading floor. Traders view market data or enter orders through pop-up windows on the computer screen. The computers work with a mouse instead of a keyboard, so traders need only point and click, using a number pad to place orders. Novices can learn the system in 20 minutes, and can enter the most complex order in less than 10 seconds.

"Users can instruct the system to work orders in the same way they would expect a good floor trader to," says Rosensaft. "For example, if someone wants to buy a large block, let's say 100,000 shares, the system will expose only part of it at a time to minimize the impact of the order on the market." An electronic market like this guarantees timely execution of orders and gives every user equal access to the action.

The Transvik system automates any type of market for any type of instrument, merely by programming in the rules and regulations of a particular exchange. The system can codify levels of privilege for different classes of members, such as traders and specialists. Although it was developed as an electronic market system, Transvik can also supplement floor activity.

So far, Transvik has not found any U.S. buyers. The company is negotiating with several operating and planned exchanges in this country, but its first market will be The Unofficial List, a small over-the-counter equities market in Stockholm. That service was scheduled to begin in late summer or early fall.

The trend is clearly toward total automation. Order routing is already mostly electronic; trading electronically is the logical next step. When it does happen, certain middle-level functions—including floor traders—will be eliminated. The traditional specialist role probably will change, which accounts for some of the resistance to the idea.

A world of truly electronic markets would also affect information providers. Brokers linked to the exchanges would have all the information at their fingertips, so information companies will have to concentrate on providing information-management services.

counts, such as pension funds.

"For the foreign-exchange and fixed-income markets, Reuters and Telerate essentially create the market," says Eugene McAuliffe, a senior analyst at First Albany Corp. "They are the equivalent of the New York Stock Exchange. This is very difficult to duplicate, so they have a virtual lock on [selling information about] these markets."

A number of smaller financial-information firms are eyeing the lucrative turf staked out by the major companies, but observers say their lack of economic clout will not be enough to crack the dominance of the top companies. Smaller players will have to be content with filling niches in the market.

PC Quote Inc., for example, offers quote systems based on networks of personal computers. But the company's chief advantage over ADP and Quotron is price, not technology. "The reason we chose PC Quote over ADP was cost," says Ernest Caruso, a Utica, N.Y., registered representative of Integrated Resources Equity Corp., a regional broker based in New York City. "I came from Tucker Anthony, where we were using ADP. But to get that same system in here would cost three times what we're paying for PC Quote." Caruso adds that he likes the flexibility of PC Quote, which allows him to see price data in several different formats.

Data Broadcasting Corp. (DBC) uses a hidden part of the Financial News Network's television signal to deliver market information and related news. DBC, an FNN subsidiary, inserts its information in the cable channel's vertical blanking interval—the black bar that appears when a TV picture rolls. The company provides quotes to some 1,500 customers, mostly individual investors who have personal computers, but the company plans to expand to brokerage houses as well.

Other niche players include Bridge Information Systems Inc., noted for its sophisticated graphics, and Knight-Ridder, which is playing off its success providing data to commodities brokers by offering statistical views of stocks, money markets, fixed-income securities, and other investment instruments.

Regardless of which companies ultimately win the information-services war, one thing is certain: Investment firms are shifting away from centralized data-processing systems and dumb quote terminals to distributed-processing networks that link corporate mainframes to branch-office minicomputers and intelligent desktop workstations. Brokers and traders benefit most from this transformation. Now they can maintain sophisticated client databases at their elbow, get access to a broader range of information, and use powerful analytical tools. As the major investment firms move quickly in this direction, the regional firms will have to follow suit. In an industry that depends on split-second decisions and complex supply-and-demand modeling, the better a company's technology, the sharper its competitive edge. ■

Henry Fersko-Weiss is a free-lance writer specializing in business and technology.

LEADING 100

COMPANY (SYMBOL/EXCHANGE)	RANK THIS MONTH/ LAST MONTH	PRICE INCREASE LAST MONTH (%)	CLOSING PRICE ($)	EARNINGS PER SHARE		LATEST DIVIDEND ($)	P/E RATIO	DEBT/ EQUITY RATIO	LATEST 12 MONTHS' REVENUE (IN MILLIONS)
				LAST QUARTER ($)	CHANGE FROM 1 YEAR AGO				
AEROSPACE									
Grumman (GO/NYSE)	1/27	16.5	23.00	.61	1.7	1.00	NE	.88	3,380.9
Rockwell Intl. (ROK/NYSE)	2/5	11.5	21.75	.81	26.6	.72	8.2	.23	11,804.4
Sierracin (SER/AMEX)	3/25	10.3	8.00	.13	NE	—	11.0	.37	73.4
OEA (OEA/AMEX)	4/2	10.2	28.38	.57	35.7	—	16.1	.00	44.4
Prec. Aerotech (PAR/AMEX)	5/28	9.5	4.38	.05	-68.8	—	16.8	.68	35.8
Gen. Motors H (GMH/NYSE)	6/20	7.9	30.75	NA	NA	.40	NA	NA	NA
TronsTechnol (TT/NYSE)	7/30	7.9	18.88	.72	-25.8	.88	9.1	.72	209.3
Curtiss-Wright (CW/NYSE)	8/19	7.6	51.25	1.15	-12.2	1.60	9.2	.21	172.4
McDonn. Doug. (MD/NYSE)	9/23	7.5	64.88	1.33	25.5	2.56	8.1	.25	13,377.3
Boeing (BA/NYSE)	10/3	7.3	59.13	.89	17.1	1.60	18.3	.05	15,205.0
CHEMICALS									
IMC Fertilizer (IFL/NYSE)	1/19	30.8	40.88	NA	NA	.37	NA	NA	NA
Am. Colloid (ACOL/NASDAQ)	2/2	30.6	16.00	.12	33.3	.44	21.9	.63	95.4
Melamine Chem. (MTWO/NASDAQ)	3/73	29.3	13.25	.31	121.4	—	10.7	.00	31.3
Intl. Genet. (IGEI/NASDAQ)	4/62	27.8	5.75	-.13	NE	—	NE	.00	3.2
Pennwolt (PSM/NYSE)	5/18	27.7	81.75	1.08	8.0	2.40	19.9	.46	1,121.4
Georgia Gulf (GGC/NYSE)	6/74	25.0	71.25	2.69	284.3	.90	9.4	.29	775.4
Detrex Chem. (OTRX/NASDAQ)	7/15	23.1	32.00	.67	19.6	1.20	18.0	.18	101.2
Free. Mc. Rsc. (FRP/NYSE)	8/33	22.6	25.75	NA	NA	2.45	NA	NA	NA
Airgas (ARG/NYSE)	9/11	20.8	16.00	.21	10.5	—	20.0	3.08	130.5
Borden Chem. (BCP/NYSE)	10/31	19.9	18.88	NA	NA	—	NA	NA	NA
COMMUNICATIONS									
Centex Telem. (CNTX/NASDAQ)	1/4	24.1	13.50	.07	NE	—	NE	.01	41.5
Checkpoint Sys. (CHEK/NASDAQ)	2/54	23.7	9.13	-.14	NE	—	83.0	.12	36.9
Artel Comm. (AXXXX/NASDAQ)	3/2	22.2	2.75	-.24	NE	—	NE	.00	5.3
IDB Comm. Grp. (IDBX/NASDAQ)	4/41	19.4	10.75	.11	83.3	—	22.9	.48	14.2
NW Telecom. (NOWT/NASDAQ)	5/10	18.9	23.00	.31	-29.5	.66	23.7	2.50	50.5
WestMarc B (WSMCB/OTC)	6/43	17.2	18.75	NA	NA	—	NA	NA	NA
US Cellular (USM/AMEX)	7/5	15.2	19.88	NA	NA	—	NA	NA	NA
ACC (ACCC/NASDAQ)	8/42	13.8	3.13	.06	NE	—	14.2	.78	35.4
WestMarc A (WSMCA/NASDAQ)	9/53	13.2	19.25	-.04	-100.0	—	24.4	9.33	106.4
Comcoa (CCOA/NASDAQ)	10/11	12.5	13.50	.04	33.3	—	NM	2.14	16.7
COMPUTERS									
Storage Tech. (STK/NYSE)	1/120	57.1	2.75	.04	.0	—	17.2	28.46	755.8
Rexon (REXN/NASDAQ)	2/184	47.4	7.00	.22	37.5	—	9.7	.17	119.2
Sigma Designs (SIGM/NASDAQ)	3/44	43.3	21.50	.36	38.5	—	17.2	.00	50.6
Systems Integ. (SIN/NYSE)	4/159	43.3	7.88	.11	120.0	1.20	21.3	.00	61.2
Intell. Elec. (INEL/NASDAQ)	5/11	40.6	11.25	.27	58.8	—	13.9	.00	93.2
Tigero Grp. (TYGR/NASDAQ)	6/161	38.0	1.38	.00	NE	—	NE	.01	.5
Miltope Grp. (MILT/NASDAQ)	7/4	32.7	7.63	.03	-57.1	—	NE	.77	63.4
Apogee Robotics (APGED/NASDAQ)	8/52	30.7	2.13	.01	NE	—	NM	.00	3.3
Distrib. Log. (DLOG/NASDAQ)	9/129	30.2	3.75	.09	NE	—	NE	.76	36.6
LDI (LOIC/NASDAQ)	10/133	29.8	13.63	.23	27.8	—	12.5	2.89	143.1
DRUG MANUFACTURERS									
Scherer RP (SCHC/NASDAQ)	1/1	39.7	28.13	.22	29.4	.36	27.0	.40	290.7
Incstar (ISR/AMEX)	2/12	37.8	6.38	.11	1000.0	—	24.5	.12	13.4
Duromed Phor. (DRMD/NASDAQ)	3/64	34.8	4.38	-.17	-100.0	—	NE	6.29	18.2
Novo Ind. (NVD/NYSE)	4/29	26.3	36.00	1.22	47.0	.51	11.7	.17	824.7
Zenith Labs (ZEN/NYSE)	5/84	25.0	1.25	-.29	NE	—	NE	.24	37.5
Jones Med. Ind. (JMED/NASDAQ)	6/11	23.0	6.00	.09	28.6	—	20.0	.09	7.2
Corrington Labs (CARN/NASDAQ)	7/63	22.5	12.25	-.15	NE	—	NE	.00	5.0
Camb. Bio. Sci. (CBCX/NASDAQ)	8/72	22.0	13.88	-.19	NE	—	NE	.05	2.6
Lifecore Biomed. (ICBM/NASDAQ)	9/57	20.7	5.13	.03	NE	—	NM	.07	3.5
Adv. Magnetics (ADMG/NASDAQ)	10/76	19.7	6.88	-.04	-100.0	—	24.6	.00	4.3

The HIGH TECHNOLOGY BUSINESS Leading 100 lists the 10 companies in each of 10 industries that had the highest stock gain over the previous month (figures as of 7/5/88).

NA – Not available NE – Negative earnings NC – Not calculable NM – No meaningful figure

COMPANY (SYMBOL/EXCHANGE)	RANK THIS MONTH/ LAST MONTH	PRICE INCREASE LAST MONTH (%)	CLOSING PRICE ($)	EARNINGS PER SHARE LAST QUARTER ($)	EARNINGS PER SHARE CHANGE FROM 1 YEAR AGO	LATEST DIVIDEND ($)	P/E RATIO	DEBT/ EQUITY RATIO	LATEST 12 MONTHS' REVENUE (IN MILLIONS)
ELECTRONICS									
Silicanix (SILI/NASDAQ)	1/226	85.0	9.25	.05	-16.7	—	31.9	.62	125.9
Andersen Grp. (ANDR/NASDAQ)	2/61	75.5	7.25	.25	NE	—	NE	2.24	51.2
Old Dominian (DOSI/NASDAQ)	3/18	71.4	3.00	.03	.0	—	NE	.31	8.4
Tekelec (TKLC/NASDAQ)	4/66	46.9	18.00	.28	1300.0	—	39.1	.00	20.1
Epsco (EPSC/NASDAQ)	5/201	41.0	13.75	.13	8.3	—	25.5	.53	26.2
Recatan (RCQT/NASDAQ)	6/189	40.8	5.63	.09	80.0	—	NE	1.01	32.6
N. Atl. Ind. (NATL/NASDAQ)	7/117	39.1	3.13	.05	NE	—	NE	.21	31.8
Baston Acqus. (BOSA/NASDAQ)	8/160	34.4	10.75	.27	28.6	—	11.1	.00	17.5
Tridex (TDX/AMEX)	9/157	32.5	5.63	.06	-85.7	—	NE	7.64	20.3
Am. Precisian (APR/AMEX)	10/25	30.8	17.00	.12	100.0	.17	50.0	.08	40.7
HEALTH									
Genetic Eng. (GEEN/NASDAQ)	1/47	197.4	1.13	-.01	NE	—	NE	.00	.3
Collagen (CGEN/NASDAQ)	2/1	60.4	8.63	-.08	-100.0	—	NE	.01	26.1
Q Med (QEKG/NASDAQ)	3/117	58.7	2.38	-.28	-100.0	—	NE	.00	12.5
Biaplasty (BIOP/NASDAQ)	4/116	42.0	1.25	-.08	NE	—	12.5	.19	4.0
Healthdyne (HQYN/NASDAQ)	5/12	40.3	4.56	-.06	-100.0	—	NE	.05	82.3
AOAC Labs (AQAC/NASDAQ)	6/102	38.1	3.19	.02	100.0	—	29.0	.10	68.0
Criticare Sys. (CXIM/NASDAQ)	7/91	37.8	6.38	.10	42.9	—	18.8	.00	10.8
Exavir (XDVR/NASDAQ)	8/113	33.3	9.00	-.19	NE	—	NE	.00	.1
Intermedics (ITM/NYSE)	9/30	32.2	42.63	.48	50.0	.03	26.5	.10	212.0
Mana. Anti. (MABS/NASDAQ)	10/114	31.9	4.13	-.42	NE	—	NE	.07	6.1
METALS FABRICATION									
Reuter (REUT/NASDAQ)	1/11	36.4	15.00	-.06	-100.0	—	NE	.70	29.2
Synallay (SYD/AMEX)	2/1	31.0	6.88	.20	400.0	—	36.2	.17	54.9
Allegheny Lud. (ALS/NYSE)	3/7	25.7	32.38	.90	21.6	.48	13.3	.40	935.5
Schwab Safe. (SS/AMEX)	4/2	25.0	18.13	.35	-16.7	.56	12.7	.00	14.0
Edgecamb (EDGC/NASDAQ)	5/12	22.7	6.75	.27	2600.0	—	19.9	12.33	572.5
R8&W (RBW/AMEX)	6/5	21.6	5.63	.15	650.0	—	NE	.90	175.9
Varlen (VRLN/NASDAQ)	7/9	21.5	24.00	.59	37.2	.57	14.9	.81	175.6
MLX (MLXX/NASDAQ)	8/32	16.9	2.63	-.15	NE	—	NE	8.31	372.7
Sifca Ind. (SIF/AMEX)	9/42	14.6	10.75	-1.45	-100.0	.25	NE	.23	69.7
Allied Products (AOP/NYSE)	10/23	13.1	20.50	.14	-84.6	—	NE	1.16	517.5
SCIENTIFIC AND ELECTRONIC INSTRUMENTS									
Brajdas (BRJS/NASDAQ)	1/2	50.0	8.25	.32	700.0	—	12.9	.52	47.5
ENSR (ENX/AMEX)	2/82	41.4	10.25	.06	-64.7	—	38.0	.01	86.8
Panatech R&O (PNTC/NASDAQ)	3/25	37.0	1.63	.51	750.0	—	2.9	.35	13.7
Kulicke & Saffa (KLIC/NASDAQ)	4/9	33.8	14.38	.03	NE	—	NE	1.00	71.1
Modern Controls (MOCQ/NASDAQ)	5/58	32.9	10.63	.18	50.0	.20	15.9	.00	7.6
Veeco Inst. (VEE/NYSE)	6/19	30.2	20.50	.28	40.0	.40	20.3	.43	232.9
Laser Phota (LAZR/OTC)	7/10	25.1	2.19	-.48	NE	—	NE	1.45	4.9
Brinkmann Inst. (BRIK/NASDAQ)	8/56	24.5	15.25	.25	127.3	—	12.9	.00	74.8
Ariz. Inst. (AZIC/NASDAQ)	9/7	23.2	5.00	.01	-75.0	—	25.0	.17	9.3
Laser Prec. (LASR/NASDAQ)	10/48	21.6	5.63	.04	-33.3	—	80.4	.01	18.9
SOFTWARE AND DATA PROCESSING									
Mgmnt. Sci. Am. (MSAI/NASDAQ)	1/47	45.6	12.38	.14	NE	—	28.8	.05	274.9
Rabbit Software (RABT/NASDAQ)	2/135	42.0	3.38	-.04	NE	—	NE	.14	5 0
Adv. Comp. Tech. (ACTP/NASDAQ)	3/143	38.0	1.38	-.16	-100.0	—	NE	.30	9.5
Comp. Factary (CFA/NYSE)	4/38	37.4	18.38	.26	36.8	—	16.4	.00	231.6
Software Pub. (SPCD/NASDAQ)	5/3	30.7	25.00	.37	76.2	—	24.5	.00	48.2
Informix (IFMX/NASDAQ)	6/119	29.7	24.00	.20	100.0	—	31.6	.00	60.3
Oigilag (DILQ/NASDAQ)	7/10	27.6	6.38	.01	-93.8	—	19.3	.01	15.3
Scitex (SCIXF/NASDAQ)	8/23	27.0	5.88	.23	NE	—	NE	.28	155.7
Comp. Oata Sys. (CPTA/NASDAQ)	9/124	25.9	13.38	.27	92.9	.12	12.2	.73	64.2
VM Software (VMSI/NASDAQ)	10/118	23.1	16.00	.10	-16.7	—	31.4	.00	32.3

SOURCE: MEDIA GENERAL FINANCIAL SERVICES

HIGH TECHNOLOGY BUSINESS. WHERE THE FUTURE BEGINS.

Trial Offer.

To try High Technology Business—with a refund guarantee on all unmailed issues—call toll-free. Or mail this coupon to High Technology Business, 214 Lewis Wharf, Boston, Mass. 02110.

- ☐ 3 years, 36 issues-$120. Save $60 off the cover price.
- ☐ 1 year,12 issues-$60.
- ☐ Check or money order enclosed.
- ☐ Please bill me later.

5REG6

NAME _____

COMPANY _____

ADDRESS _____

CITY/STATE/ZIP _____

1-800-962-2962.

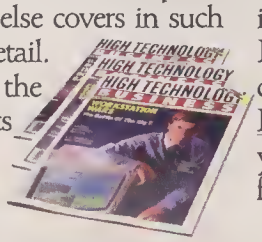
New subscribers only please.
Basic rate: $60/year.

Making money while shaping the future. That's the one thing that the business of high technology is all about. It's the one link among hundreds of thousands of readers of High Technology Business every month: They want to profit from trends that are transforming our lives and businesses, and they know High Technology Business is must reading to help them profit.

Profit—from expertise, judgment and resources that open doors and minds, giving you the edge on the future.

Profit—by being among the first to see and understand trends and products that no one else covers in such depth and such detail.

Profit—getting the edge from reports that name names, list addresses and phone numbers, so you know precisely which companies and researchers are poised to strike it rich...and so you can plan how to cash in yourself.



High Technology Business gives you the edge—in credible, no-nonsense, plain-spoken, clear-eyed coverage that can pave your way to profits every month. And now you can get High Technology Business with none of the risks associated with high technology business. If it's not everything we promise and more, you can cancel your susbscription at any time, for a full, unquestioned refund on all unmailed issues. How can we make this offer? Because we don't expect you to cancel. Losing the High Technology Business edge could mean losing your chance to profit from the future.

HIGH TECHNOLOGY
BUSINESS

214 Lewis Wharf, Boston, MA. 02110

Steaming

BY EDWARD WARNER

POWER SYSTEMS INC.

A computerization program delivers big benefits to a boiler maker

ONE OF THE great advantages of using computers to design products is that engineers can create a library of computer images of standard components. Want to build a new clock? A computer-aided design (CAD) program speeds the process by letting your designers combine various drawings of gears and other parts used to build previous models.

However, companies that build products to customer specifications cannot reap such benefits, because standard CAD programs can't keep up with constantly changing requirements.

That was the problem facing the Power Systems division of Combustion Engineering Inc., a multi-national company with $3 billion in annual sales. Power Systems, based in Windsor, Conn., custom-builds steam-generating boilers to suit the individual needs of its customers, mainly electrical utilities. The boilers, which may be several stories tall and incorporate 160 miles of tubing, are manufactured in pieces at the division's factories, then shipped to the customer's site for assembly. Large boilers can cost more than $100 million.

With requirements like these, the division can forget about using a library of canned CAD images; even assembly lines are out of the question. Yet despite the division's size—its sales make up about one-third of its parent company's revenue—Power Systems has extensively automated its design process and is now three years into a five-year plan to computerize all of its operations.

Combustion Engineering is already seeing payoffs from the new system: certain boiler components get built 15 to 20 percent more quickly, the company saved $1.5 million on programming factory equipment, and payroll has grown only 10 percent in an operating unit where sales grew 30 percent.

When the automation effort ends in 1990, every Power Systems department—including its manufacturing facilities—will be equipped with computers that can trade designs, specifications, and orders, says William H. Pollock, director of the automation program. In 1990, he says, the system will automatically route customer orders to all affected departments, from billing to contract scheduling and project management. One result: the materials needed to fill an order will be ordered just minutes after that order's arrival. Pollock says the division already uses a network between the engineering and document-publishing departments to transmit electronic blueprints directly

into the pages of an operating manual before it goes to press.

Although many non-manufacturing companies have accomplished total computerization, such programs remain rare among manufacturers, reports Julie Pingry, editor of *CIM Strategies*, a newsletter on computer-integrated manufacturing (CIM).

Power Systems' automation effort has focused on reducing turnaround time—the lag between receiving and filling an order. By 1990, Pollock expects to cut that time in half. The 15 percent reduction achieved so far affects only certain parts of a boiler under construction, but Pollock says that's enough to help the division under-bid competitors and build boilers faster. As turnaround time falls, so do costs, though not in a one-to-one relationship.

Another automation goal is to keep payroll down as business expands. Combustion Engineering trimmed its staff when electrical utilities ran into hard times earlier in this decade; now, increased demand for electricity has caused a rebound.

A third goal is to bring everyone closer to the latest project data, says Pollock, who notes that the $50-million automation effort will put a personal computer on the desk of nearly all 3,500 Power Systems employees, including all 1,500 of its engineers. About 40 key executives will receive IBM-compatible computers with access to the company's most crucial data, as well as to electronic news services such as Dow Jones News Retrieval. Using a special executive information system from Boston's Pilot Executive Software, the executives will be able to get quick briefings on news affecting the division or its customers, or dive into the corporate database to analyze sales or inventory, complete with instant charts.

In Power Systems' 10 factories, employees will use touchscreen-equipped personal computers that tie each job to its electronic "paperwork." For example, factory workers will be able to refer to the blueprint associated with a work order by calling it up on the screen. More importantly, that work order will reflect the latest changes in the American Society of Manufacturing Engineers (ASME) code, which governs acceptable design practices. Previously, work orders consisted of stacks of paper, and factory managers worried that designers might inadvertently use outdated ASME specifications.

Because Power Systems' factories were already highly automated, the division has concentrated on improving the programming for the computers that control about 200 of its more than 300 machine tools. To that end, Power Systems recently dumped its software for programming those computers in favor of an $8,000 system that runs on a personal computer and can be used by computer neophytes. The alternative—expanding the old programming systems—would have cost at least $750,000, says Ronald F. Konopacki, director of manufacturing services. The division's manufacturing workers have already used the new programming software to write unique programs for each of 100 control computers, saving the division another $750,000, he says.

Power Systems has initially focused its automation effort on the engineering and design department, says Daniel F. Senatro, engineering-automation manager. The crowning glory of that department's automation effort is one of the nation's first expert systems for product design.

An expert system is software that compiles the accumulated knowledge of experts in a given field. The Power Systems program contains the design rules used by the division's top designers. Other designers can retrieve these collections of rules to design a boiler component by component, in much the same way other manufacturers use a CAD system's library of parts images. The expert system also ensures that the organization's best design know-how is not lost to the company with the departure of a top designer.

The system—called the ICAD System because it's based on a two-year-old program of the same name from ICAD Inc. of Cambridge, Mass.—will eventually contain all the design rules needed to produce a boiler. At present, the system contains only the rules for building some components, such as furnace walls. If a customer specifies 80-foot interior walls, explains Senatro, the ICAD System determines how many individual sections must be joined to make that wall, and then creates an initial design. The design is then fleshed-out with conventional CAD drawings.

Senatro figures the ICAD System has helped shave 1,400 man-hours off the 3,500 hours it once took to design furnace walls. In addition, the system has helped reduce the cost of boiler design, formerly about 15 percent of the total cost, to about 12 percent—a savings of $3 million on a $100-million boiler.

Combustion Engineering built about 40 percent of America's steam-generating boilers, which is one reason Power Systems earns almost half its revenue by making replacement parts. One popular part—the "economizer," which squeezes the last drop of heat energy from steam—has had its design rules entered in an expert system. Senatro says this move has reduced the part's three- to four-month turnaround time by about 20 percent. In the parts business, responsiveness usually outweighs any savings in product cost, notes controller Bruneau. A shut-down power plant can set a utility back $1 million a day. "If you can get that part there faster, you've got an advantage" over competitors, he says.

Power Systems is also recording cost-estimating rules in its expert system. Ultimately, the division plans to use the system to generate both a design and a super-accurate bid estimate, ensuring that the division does not lose money on a job and can fly into action at the moment of contract approval. Such "process-planning" systems, which translate customer specifications into drawings, estimates, and a bill of materials, are still relatively new. "I don't know any [other company] that's rolling up process plans," says Konopacki.

Materials account for about half of a boiler's cost. To ensure more accurate estimates, the engineering department has adopted a software program that translates customer specifications into a proposed boiler configuration. This program, called the Selection System, cuts the configuration process from two or three weeks to two or three days, says Senatro. The program's better estimates of needed materials, he adds, have reduced each boiler's materials cost by 3 to 5 percent while avoiding unnecessary inventory. This can slash as much as $2.5 million from the cost of a $100-million boiler.

Impressive rewards pervade the automation effort at the Power Systems division. Unlike many companies, Combustion Engineering has not sacrificed immediate results in pursuit of an aggressive long-range strategy. ■

lead to the development of everything from medicines to useful strains of bacteria. Scientists also expect to identify some inherited disorders caused by errors in the second code.

This newly deciphered code plays a key role in a later step in protein synthesis. This finding provides a second point in the process of protein synthesis at which the interpretation of a cell's genetic should be relatively easy to describe the details of the instruction process in other examples, after they showed in great detail how the second kind of

Opinions and information expressed in *Newsletter Digest* are the responsibility of the individual newsletters' authors.

into the pages
before it goes

Although n
companies ha
computerizati
main rare an
ports Julie Pin
egies, a nev
integrated ma

Power
fort
turna
twee
order. By 199
that time in ha
tion achieved s
parts of a boile
Pollock says t
division unde
build boilers fa
falls, so do cos
one relationsh

Another au
payroll down
Combustion E
staff when el
hard times ea
increased den
caused a rebou

A third goal
er to the lates
lock, who no
automation ef
computer on tl
Power Systen
all 1,500 of its
executives wil
computers wi
ny's most cruc
tronic news se
News Retriev
tive informati
Pilot Executiv
tives will be al
on news affect
tomers, or div
base to analyz
plete with inst

In Power Sy
ployees will u
personal comp

its electronic "paperwork." For example, factory workers will be able to refer to the blueprint associated with a work order by calling it up on the screen. More importantly, that work order will reflect the latest changes in the American Society of Manufacturing Engineers (ASME) code, which governs acceptable design practices. Previously, work orders consisted of stacks of paper, and factory managers worried contains only the rules for building some components, such as furnace walls. If a customer specifies 80-foot interior walls, explains Senatro, the ICAD System determines how many individual sections must be joined to make that wall, and then creates an initial design. The design is then fleshed-out with conventional CAD drawings.

Senatro figures the ICAD System has helped shave 1,400 man-hours off the have reduced each boiler's materials cost by 3 to 5 percent while avoiding unnecessary inventory. This can slash as much as $2.5 million from the cost of a $100-million boiler.

Impressive rewards pervade the automation effort at the Power Systems division. Unlike many companies, Combustion Engineering has not sacrificed immediate results in pursuit of an aggressive long-range strategy. ■

Newsletter Digest

Excerpts and expertise from newsletters covering the latest technological developments.

BIOTECHNOLOGY

APPLIED GENETICS NEWS

Faster, Cheaper AIDS Test Found

Researchers working at New York University have detected in urine the presence of the virus that causes AIDS. They found evidence of AIDS infection in the urine of 79 of 80 patients who also tested positive in blood tests. Urine samples taken from these patients contained antibodies usually produced in the presence of the human immunodeficiency virus, HIV.

The detection of antibodies in urine should allow the development of a urine-based test for AIDS. Such a test would probably be less expensive and a more acceptable way to screen huge numbers of people, especially in Africa and South America, where people are reluctant to give blood samples.

Antibodies to HIV have been detected in saliva, semen, and other human fluids, but never before in urine. The research team identified the antibodies with detection methods used to identify the presence of antibodies in blood.

Researchers had not previously searched urine for the presence of HIV antibodies because blood-borne viruses, such as the one that causes AIDS, usually do not produce antibodies in urine. The presence of the antibody in urine is difficult to explain. One suggestion is that people infected with HIV may somehow excrete antibodies for fighting the disease, one possible reason that the body is unable to adequately fend off the virus. Explaining the antibodies' presence in urine may lead to further explanations about how the HIV virus works.

New York University is seeking a patent for the technique and is negotiating with several companies to license the process for use in a urine-based test. The technique might allow for development of a dipstick-type test that could be performed easily by health-care providers or even at home. The FDA has said that it did not want to approve any home-based AIDS tests, saying such tests are more appropriately handled at medical centers.

MIT Scientists Decipher Second Genetic Code

A second genetic code, which has eluded molecular biologists for two decades, has been deciphered by researchers working at the Massachusetts Institute of Technology. This code directs one of several steps in the synthesis of proteins inside cells and could be an important step in providing a new way for scientists to make proteins to order. It could lead to the development of everything from medicines to useful strains of bacteria. Scientists also expect to identify some inherited disorders caused by errors in the second code.

This newly deciphered code plays a key role in a later step in protein synthesis. This finding provides a second point in the process of protein synthesis at which the interpretation of a cell's genetic instructions can be altered. The code helps explain a crucial aspect of protein synthesis; the attraction of building blocks, amino acids, to genetic materials inside the cell.

The MIT scientists said that, with the basic nature of the code now known, it should be relatively easy to describe the details of the instruction process in other examples, after they showed in great detail how the second kind of

CONTENTS

instruction works in the case of one amino acid.

Molecular biologists have expressed some amazement that the second code is so simple, much simpler than the master code. In protein synthesis, the original genetic code on the RNA is copied into a similar material called messenger RNA. Then the messenger RNA is read by other molecules called transfer RNA. These, in turn, bind to amino acids, assembling them in the proper order to make a particular protein. There is a different transfer RNA molecule for each of the 20 types of amino acids found in cells. What has been missing in this explanation was an understanding of how a particular RNA could cause the binding of a particular amino acid. The second genetic code is the language of the instruction on the transfer RNA that specifies which amino acid will be attracted.

Much research has been under way in recent years on the three-dimensional structure of the transfer RNA. The MIT group finally found that there was one tiny piece of a transfer-RNA molecule that determines its function. The piece consisted of two bases, like the bases that form DNA, stuck together. When they took these two bases away from a transfer RNA that usually recognized the amino acid alanine, the transfer-RNA molecule became inert. The transfer-RNA molecule no longer recognized any amino acid.

Then the researchers took that tiny piece of the alanine transfer RNA and put it into a transfer RNA that normally recognized the amino acid glycine. It then recognized alanine instead. They also put the piece into a transfer RNA that normally recognized uridine. Once again, the transfer RNA was converted to one that recognized alanine.

Dr. Paul Schimmel and Ya-Ming Hou are heading the research effort at MIT. Looking back, Dr. Schimmel thinks that perhaps it was the very simplicity of the second genetic code that threw researchers all these years.

SUPERCONDUCTING

ELECTRONIC MATERIALS TECHNOLOGY NEWS

Process Blends Superconductors and Semiconductors

Scientists at the New York State Institute on Superconductivity at the State University of New York at Buffalo have developed a single-step process that incorporates superconducting materials into semiconducting devices.

The scientists have demonstrated that superconducting materials can be deposited in thin films at 400° Celsius, a lower temperature than ever before, ensuring a high-quality superconducting film. With this new process, thin films can be developed in one step without treating the ceramic superconductor at a high temperature with oxygen. In previous methods, the thin film was treated with oxygen while being heated at 700° to 900° Celsius, usually for more than 30 minutes.

Incorporation of the superconductor into semiconductor devices is virtually impossible with previous methods, because of the upper temperature limit for base materials at about 450° Celsius.

In the new process, a thin film is deposited at about 400° Celsius. The SUNY-Buffalo team deposited the superconducting material on strontium titanate and silicon. "We were able to eliminate the high-temperature annealing process by applying an oxygen plasma to assist the direct formation of the superconducting phase," reported David Shaw, professor of electrical engineering.

The process uses an excimer UV laser to vaporize the material and deposit it on another material in an ionized oxygen atmosphere. Dr. Shaw added, "With the low deposition temperature, we are ready to make multilayer structures for fabricating electrical devices."

SEMICONDUCTORS

INTERNATIONAL COMPUTRAN CORPORATION TEC REPORT

Toshiba Opens Way for Larger-Density EEPROMs

Toshiba Corp. has developed a NAND-type memory cell that opens the way toward expanding the density of EEPROMs dramatically. With memory cells measuring only about a third the size of those for DRAM devices, researchers indicated that it will be possible to leap one generation ahead of DRAMs and create a

new memory market replacing the existing one for magnetic disk-storage devices.

At present, the cell area for EEPROMs is about 10 times as large as the cell area for DRAMs. Thus, although the latest DRAMs have a memory capacity of 1 megabit, the largest EEPROM available today is only about 64 kilobits. Toshiba has devised a new circuit technology that reduces the EEPROM cell area to 9.3 square microns.

Conventional EEPROMs use NOR-type memory cells arranged in a parallel manner against the output. While NOR cells make rewriting programs in specific memory cells easy, their major glitch is the large cell space they require due to the need for a large number of selection transistors and contacts in addition to the memory transistor.

NAND cells, on the other hand, are serially arranged, and were thought to be unsuitable for constructing EEPROMs because selective program rewriting of specific cells was not possible.

Toshiba researchers discovered that the system will not be affected if the erasing-writing operation is done in 8-bit increments. The prototype EEPROM developed by Toshiba is in the scale of an LSI semiconductor device with its cells arranged in 128 rows in 8-bit increments. Each 8 bits in Toshiba's device are NAND cells arranged serially. The number of selective transistors and contacts is about a quarter to an eighth of those used in NOR-type EEPROMs.

SDI MONITOR

Diamond Film Technology Hailed as Breakthrough

"Once in a while we achieve a true breakthrough. One of those is the application of thin-film diamond technology to electronics," SDIO Director Lt. Gen. James Abrahamson told a recent SDI conference.

Abrahamson said the idea was pursued for quite a while and was finally solved by separate teams of university and industry researchers working together. "Looking across traditional fields of science to find ways in which we can solve problems is where the real progress is," he said.

The idea of diamond films for semiconductors has generated a lot of interest because of diamond's characteristics of unexcelled hardness, absolute inertness, thermal conductivity five times that of copper, and an electric-field breakdown strength far greater than that of many other semiconductor materials. "Diamond, if it can be processed and used properly, may be the ultimate material for very, very large scale integrated circuits," Abrahamson said.

Abrahamson said SDI has been funding the work at several labs "nearly exclusively." The Research Triangle Institute explored a new technique for chemical vapor deposition, which was coupled with research being done at Penn State.

The first crystals grown with this process could not be used for semiconductor research, but the teams kept working and started collaborating with MIT Lincoln Labs. Other suggestions were provided by IBM researchers.

When all the efforts were combined, Abrahamson said, "that's when the payoff really began to happen. We clearly found a way to grow thin-film diamond."

For SDI, the development could mean better computer chips with increased radiation hardness. Diamond films could also allow much higher temperatures because of thermal conductivity.

"We still have to do a lot of characterization and additional research," said Abrahamson, "but it [diamond-film technology] will transform the electronics industry for satellite and space applications, and it will not stop there."

SEMICONDUCTOR ECONOMICS REPORT

'Robust' Approach Found for Power MOSFETs

Advanced Power Technology of Bend, Ore., recently announced a line of power MOSFETs that provides the highest switching speeds (1 megahertz) now available. What is unique is that this was done by going to a lower resolution and a more rugged process. Instead of decreasing the resolution, Advanced Power Technology developed a process that allowed resolution to be increased from three to six microns and still

obtain higher speed performance.

The key factor in the speed improvement is an interdigitated layout. This design ensures that the source metal does not overlap the poly gate creating extra parasitic capacitance. The A1 gate metal reduces the RC time constants. In addition, Advanced Power Technology designers use six 10-mil A1 wire bonds to minimize the source lead inductance.

Parasitic bipolar action is reduced by placing the A1-sourced metal deep into the source/channel material. In addition, this technique reduces the on resistance. A large (320×320 mil) die is then soldered to a metal substrate to maintain the low resistance and to provide the necessary heat sinking.

This approach to MOS structures is also being applied to some new VLSI circuit designs to obtain the same performance advantages.

AEROSPACE

C³I REPORT

New Missile Seeks Land Targets

The Navy is buying an off-the-shelf guidance system to enable an existing anti-ship missile to sniff out important targets on land. Naval planners anticipate that the new missile will be tested this fall and will deploy to ships and aircraft in the fleet sometime in 1989, said Captain Donald Finch, program manager for the Standoff Land Attack Missile (SLAM).

The missile, built by McDonnell Douglas Corp., also may be leading the pack in the race to build a common land-attack missile for use by all the military services.

SLAM uses the propulsion system and warhead of the Navy's Harpoon missile, which is 100 percent effective since 1982, and has the infrared seeker of the Maverick missile. The seeker doesn't merely home in on a heat source as other IR missiles do. It senses heat, and with that information produces an image sent back to a TV screen on a ship or aircraft, where an operator uses a joystick to guide the missile to its target.

Connecting the infrared sensor to the TV screen is the same data link that's on the Walleye glide bomb, which is nearly unjammable, said Finch. To jam the data link, an enemy would have to place a high-power jammer between the missile and the joystick operator.

Although the improvements that made SLAM possible don't represent a leap in technology, the deployment of the missile will open several new opportunities for ship and land bombardment. The missile is intended to strike at high-value targets in congested areas, such as communications command posts in cities where widespread damage isn't acceptable, or specific ships clustered together with enemy or even friendly vessels.

The Harpoon cruise missile with the fleet has an active radar seeker. Officials fear it might not be effective against ships clustered closely together—at least not as effective as SLAM.

The new missile will have help from other guidance systems than the Maverick seeker, explained Finch. It also can be an autonomous missile that works with the Harpoon inertial navigation system and the Navstar Global Positioning System when its satellites are in orbit.

With Harpoon inertial navigation, the missile could hit a building 60 miles away. But with help from Navstar, it could "pick the third window on the second story of a building 60 miles away," Finch said. Finch made his comments at a recent Aviation and Space Writers conference in Boston.

SLAM will have a 500-pound high-explosive warhead, the same as the one on the Harpoon missile, which is capable of destroying a hardened aircraft hangar or command center on land. The Harpoon can also inflict significant damage on an armored warship.

The Navy will be able to fire SLAM from the A-6 Intruder medium bomber or the FA-18 Hornet fighter-bomber. The missile also can be fired from any launcher that can fire the Harpoon, be it on a ship or submarine.

SLAM is expected to cost about the same as the $600,000 Harpoon. The new missile is not expected to replace the shore-bombardment firepower of the Navy's reconditioned Iowa-class battleships, which can saturate targets with 400-pound high-explosive shells fired from 16-inch guns.

Finch said SLAM will be the leading candidate for a Defense Department-wide land-attack missile. The reason, he said, is that it's the only one that will fit

Navy and Air Force planes. The Air Force's entry in the future competition probably will be the AGM-130 and the Popeye missiles, which won't fit on Navy aircraft.

Finch said SLAM also could be a good candidate to be fitted with an anti-radiation warhead, allowing it to seek out and destroy enemy radar installations as well as surface-to-air missile sites.

Plans also are in the works to improve SLAM. Future upgrades will include very high speed integrated circuits (VHSIC) and other advanced technology. Finch said DOD planners have yet to decide whether such an upgraded SLAM will be affordable.

Marquardt Builds Boilerplate Scramjet

A leading pioneer in hypersonic propulsion is building "boilerplate" models of supersonic-combustion ramjet (scramjet) engines for the X-30.

Under the sponsorship of the National Aerospace Plane (NASP) program, Marquardt Co. of Van Nuys, Calif., is resuming scramjet research, which was largely abandoned in the late 1960s. The company, which did pioneering studies on air-breathing "aerospaceplanes" in the early 1960s, is focusing on engines for the X-30 research vehicle.

The NASA/Defense Dept. NASP program plans to start engine development in fiscal year 1990. Marquardt, teamed with Pratt & Whitney, is competing against Rockwell's Rocketdyne division for the scramjet development contract. Six to eight of the winning team's engines will be tested on each X-30 in the mid-1990s.

During the past year, Marquardt has been building boilerplate engines for Project Cedar, an engine research program funded by the NASP joint program office. The boilerplate scramjets burn hydrogen fuel but are cooled with water. Actual NASP engines will use hydrogen cooling and lighter materials.

The Cedar program is "pushing to as high a performance and Mach number as we can in boilerplate," said Arthur Thomas, who recently retired as Marquardt's vice president for engineering. The engines are small in size, with flow areas of two square feet, compared with the 80-square-foot flow area for operational NASP engines.

Marquardt's Cedar tests focused on studies of combustors. "We were able to obtain results that closely matched our analytical predictions," says Robert Budica, Marquardt's vice president of special programs.

Engineers duplicated tests carried out in the 1960s with present-day instruments and analytical techniques. "The numbers matched," Budica said. The tests increased Marquardt's confidence in 1960s-vintage data, a valuable resource for the current NASP program.

The company is also testing subscale versions of Pratt's boilerplate engines. Built of steel and copper, the Pratt engines had flow areas of around eight square feet.

Both the Cedar and Pratt tests were done on Cell 2, Marquardt's Mach 8 test facility. The cell uses a "sudden expansion" heater—a high flow-rate hydrogen or propane burner—to obtain the high temperatures needed for scramjet tests.

Marquardt will upgrade Cell 2 to serve as one of NASP's large-scale engine test facilities (Aerojet TechSystems is building a second test facility in Sacramento, Calif., for Rocketdyne). The Marquardt cell will include a larger heater with a flow rate of 700 pounds of gas per second. The company will also install two water-cooled supersonic nozzles, engine thrust stands, and new oxygen and propane tanks.

Marquardt will spend another $20 million to upgrade three more in-house test cells. By contrast, similar upgrades to an arc-heated wind tunnel at the Air Force's Arnold Engineering Development Center will cost $300 million. Arnold will later spend another $700 million for a magneto-hydrodynamic air accelerator to reach Mach 18 speeds on its facility. The NASP upgrades will increase engine test durations from 35 seconds to 140 seconds. "It will give us a real national capability in high-speed engines," Budica said.

While Cell 2 is being converted for large-scale tests, Marquardt is continuing Cedar experiments in the adjacent Cell 5. "A lot of work will be experimental, aimed at optimizing combustors," Budica said. "We're going to be looking at injecting fuel at different points, different flow rates, and operating at off-design conditions."

Beginning this summer, Marquardt will use

Cell 2 for further tests of Pratt's boilerplates. Experiments will begin with flow areas of 16 square feet and increase in size as the teams move toward proof-of-concept boilerplates.

The proof-of-concept scramjets will be "rubber engines," with final sizing based on airframe requirements. "There will be a lot of pulling and stretching in going from proof-of-concept to what will actually fly," Budica said. "It's not like matching a Boeing 747 to a turbofan such as Pratt's JT9D or General Electric's CF6. The degree of integration required is an order of magnitude more demanding."

The move from boilerplate to actual flight hardware will not begin until NASP has selected a single airframe contractor in FY 1990. The winning engine contractor will adjust its design to fit the selected airframe, build a flight-weight version with advanced materials, and test the engine in its large-scale test facility.

Pratt is already designing flight engines for test at Marquardt. "It's a tremendous challenge," Thomas said. "They're solving all the problems that Marquardt is solving in boilerplate, only they have to do it in flight-weight." The flight-weight ground tests will be followed by experiments on the X-30—which won't be bound by the limitations of ground-test facilities.

SPACE COMMERCE BULLETIN

LTV Pursues Contract for Lightsat Rocket

Dallas-based LTV Aerospace, builder of the Scout rocket, is proposing to develop an entirely new booster to launch the Defense Advanced Research Project Agency's (DARPA) lightsats—small, inexpensive communications and sensing satellites now under development.

LTV Aerospace was one of four companies to win a four-month study contract, which was worth $300,000. This contract called for investigating small launch vehicles that are capable of lifting payloads as heavy as 1,500 lbs. into a 400-nautical-mile circular polar orbit. Noticeably absent from the winner's list were American Rocket, E'Prime Aerospace, and Pacific American Launch Systems—entrepreneurial companies that are going after a smaller-payload market.

LTV Aerospace officials, who could not provide details at our deadline, said that the current Scout rocket, which NASA uses to launch scientific payloads weighing no more than 450 lbs., will not satisfy specifications, and neither will the advanced Scout 2 rocket. "It's a whole new ballgame," a company official said. "It won't be a derivative." LTV Aerospace's rivals include TRW and Lockheed Missiles and Space, both of which are reportedly offering off-the-shelf hardware or refurbishment of existing military systems, as well as Houston-based Space Services, which is proposing its Conestoga booster. "It makes us look great," a Space Services official said.

E'Prime officials were expected to meet with DARPA to find out why their company wasn't selected. American Rocket officials, meanwhile, said they would pursue NASA's small vehicle procurement, which is expected to begin this summer. Pacific American Launch Systems couldn't be reached for comment.

The fate of the lightsat program is anything but certain. Air Force Secretary Edward (Pete) Aldridge has attacked the program repeatedly, derisively calling the satellites "cheapsats." Aldridge believes that the military ultimately saves money when it buys expensive, redundant satellite systems, because such systems usually outlive their design lives. If it hadn't been for such satellites, he said, U.S. security would have been severely compromised during the launching hiatus brought on by the shuttle disaster and subsequent booster explosions.

Under the new DARPA contract, contractors must show that they can provide low-cost, expendable rockets capable of:

- launching 1,000 lbs. to 1,500 lbs. into low-earth orbits,
- launching on demand using dry pad configurations,
- adapting to different payload weights and insertion requirements, and
- carrying off launch within 72 hours.

Ultimately, the company that wins the contract will be responsible for four launches, beginning in 1990, according to DARPA officials. Following normal procurement practices, the winning company also would be able to commercialize design, the DARPA officials added.

Transputers: Heart of the Desktop Supercomputer?

The *transputer?* We've heard a lot about it—mostly negative reports. There's no floating point. The parts don't work. Deliveries are a problem. There's no software. However, it turns out that almost none of these statements are true today. It's worth spending a little time looking at the transputer in its historical context.

The transputer is a microprocessor, the current generation of which is based on ideas formulated by an Englishman, Iann Barron, in the late 1970s. Barron, the micro systems designer, and two Americans interested primarily in high-speed RAM, sold the idea of a company to build these products to the British National Enterprise Board BT. It was named Inmos. With government funding behind it, the company grew rapidly both in the U.K. and the United States.

The facilities in the U.S. concentrated on both static RAM and DRAM; U.S. employment reached a peak of about 1,200. In the U.K. the company concentrated on the microprocessor business, with the idea from the beginning of building a product that could be used in parallel processors or as a stand-alone processor.

In 1984, the bottom fell out of the RAM markets. Overcapacity and Japanese competition combined to nearly wipe out the U.S. RAM makers. Inmos was not immune to these problems, and what had started for the British government as an investment became a hemorrhage of money.

Moreover, the Thatcher government was dedicated to privatization. Inmos, therefore, was sold to the conglomerate Thorn EMI in 1984. Over the next three years, Inmos went through a series of organizational convulsions that resulted in drastically trimming the work force and reshaping product and marketing strategies. At one time during this period, Thorn EMI offered Inmos for sale. However, no taker appeared, so management pressed on.

The perseverance seems to have paid off. A company spokesman indicated that, this year, Inmos has turned the profitability corner, showing positive results for the first quarter of 1988, and being profitable on a month-to-month basis as well. A lot of overhead was cut, including a large manufacturing plant in Colorado Springs that mostly produced static-RAM memory chips. The plant, which was closed last year, will be sold to Cray Research. Inmos also let go all but 160 of its U.S. employees. Thorn EMI is no longer looking for a buyer for Inmos, but is seeking one or two minority partners, preferably British, to help promote the microprocessor business.

Inmos is alive and well and living principally in Bristol, England. The transputer is also doing well. The flagship of the transputer family, the T800, was shaken out in 1987 and is now available in quantity. The older versions, the T414 and T212, are now established products.

These microprocessors are better established in Europe and Japan than in the United States, however. Inmos won't give exact figures, but transputer sales in Europe are greater than in the United States, which has more home-grown competition, and sales in Japan recently overtook the European business. Transputers are being designed in a wide variety of products in both regions, mainly as controllers in laser printers and video communications devices. IBM Japan has developed a transputer-based image recognition system for the PC/AT, for example.

The core of the T800 is the 32-bit 10 (RISC) MIPS processor inherited from the T414, to which has been added a 64-bit floating-point unit capable of sustained performance of 1.5 MFLOPS. (These performance numbers are manufacturer's claims for the T800-20 chip, which is the T800 operating at 20 MHz. The T800-30 microprocessor, which clips along at 30 MHz and is now available, improves performance by 50 percent.) The highly integrated chip also carries a configurable memory controller, four KB high-speed RAM, four Inmos serial links that can operate up to 30 Mb/sec, 32-bit wide 26 MB/sec. memory interface, and high-performance graphics support.

There appear to be three reasons why the transputer has drawn so much attention as the processor of choice for add-in boards. First, as shown above, the chip's performance is comfortably in the ballpark of state-of-the-art RISC processors and is significantly better than the workhorses of currently marketed workstations. Second, the transputer takes up less room than its contemporaries; not only is the chip package itself

compact, but fewer support chips are needed. Third, the transputer architecture is designed for parallel processing on the distributed memory, message-passing model.

It was this latter characteristic that first attracted the attention of the add-in board designers, who found they could pack four transputers and 16 MB of RAM onto a single board, and run that board with the power supply of a PC. What was missing in the first few years was software.

Inmos designed a programming language, Occam, to take advantage of the computing model of the transputer. Trouble was, Inmos failed to take account of the resistivity of the development community to new programming languages.

Occam has interesting features of synchronizing processes and for interprocessor communication, but few people wanted to take the trouble to learn to use them. Distributed-memory parallel processing is at best a difficult model to learn if one has a sequential orientation, and users avoided it. The later generation of software gives the user access to more popular computer languages, such as C, Fortran, and Pascal.

With these tools in place, we seem to be experiencing a take-off in the transputer-based PC add-in board business. One of the companies that has been at it the longest is Computer System Architects (CSA) of Provo, Utah. Formed in 1981 as a consulting firm, CSA worked with several major computer manufacturers to provide internal funding for the transputer board development. Glen Lowry, director of marketing for the company, notes that business has skyrocketed in recent months, saying that CSA "can't keep up with demand." March business tripled from the previous year.

John Poplett, director of the parallel-processing group at Definicon of Newbury Park, Calif., thinks the products are about to take hold, after what he calls "an incredibly slow lift-off," which he blames on the decision, since rescinded, to make Occam the central programming language. Now, he says, C compilers for the transputer "are popping up all over the place." And on the horizon: Fortran.

What kind of brute power can the PC user get with his transputer boards? The answer seems to be, about as much as you want.

CSA's Lowry offers the rule of thumb as 100 MFLOPS for $100,000. That formula is based on the use of extension cabinets featuring interface boards in the PC. A rough rule for the industry seems to be $1,000 to $2,000 per MFLOP, with arrangements available for just about any amount of power desired, up to the power of a mini-supercomputer.

So far, buyers of this kind of capability have to be classified as the pioneering types. Many of the boards have gone into university environments, to serve as testbeds for parallel-processing concepts and as low-cost computing power, and some into OEM shops to become the processing engines for specialized-application products.

These sales are now beginning to result in systems purchases, according to Lowry of Computer System Architects. He cites the example of the multi-user rendering box developed by one OEM that has successfully entered the market. The university applications too have commercial importance. For example, an earthquake model developed by a university researcher is now in demand at other institutions.

Craig Davidson, principal of Mechanical Intelligence of Cardiff, Calif., designed the Apple Macintosh transputer add-in boards made and sold by Levco of San Diego. He, too, sees the beginning of acceptance of the new products, although Levco so far has delivered only 30 units. Davidson was motivated to work on the transputer boards out of frustration with the limited graphics available on PCs only four years ago. By 1986, Davidson had designed a transputer board for the Mac; Mac II and SE boards followed in 1987.

Davidson thinks that savings in turnaround time is the key factor in market acceptance. Another source concurred, commenting, "When you need turnaround time, using a single transputer is faster than using a Cray."

We have mainly concentrated on transputer-based products in this article because of the parallel-processing implications, and because of the worldwide interest in using the device in such a wide variety of ways. The add-in board business is not confined to personal computers. Such companies as Sky Computers and Mercury Computer Systems produce add-in array processors and other products for PCs, Sun, and other uses. A Denver startup, Topologix, offers transputer boards for the Sun that, they claim, boosts the workstation power by 680 MIPS. In another effort, Nelson Computer Research, a startup in Dublin, Calif., plans to deliver to Lawrence Livermore Laboratories a prototype add-in board using a proprietary processor chip.

Unix Takes On Unix

Ever since the Sun/AT&T alliance was announced, the other players in the Unix world have been looking for a way to differentiate themselves. It's as if AT&T, the original developer of Unix, had soiled its hands by throwing in its lot with Sun.

Well, the rest of the Unix world seems to have found a way to make this differentiation and at the same time ensure that the waters will remain muddy. In May, IBM, DEC, Hewlett-Packard, and four others announced a new Unix, under the auspices of the Open Software Foundation (OSF) and promoted by a "standard" developed by the IEEE (the Institute of Electrical and Electronic Engineers). How this new Unix will differ from the "classic" Unix is not clear; what's certain is that it will not be the same as the AT&T/Sun offering.

As Microsoft tells the story, the OSF is "concerned over the evolution of the Unix standard.... Thus the recent alliance between AT&T and Sun Microsystems has alarmed many vendors of minis, mainframes, and technical workstations. In particular, these vendors have been concerned about the future evolution of Unix-related standards, and timely access to technology embodying these standards." Microsoft, while not a sponsoring member of the OSF, has stated that it would like to be. At the same time, Microsoft is continuing full speed ahead on its combined Unix project with AT&T, which is designed to provide a common platform for Unix on 80386-based systems.

The members of OSF have decided to work together to provide implementations of the key standards formulated by the X/Open group and the "most important" standard, Posix. The idea seems to be for DEC, IBM, and others to be able to offer their customers systems software that embodies nonproprietary standards.

I can understand that the vendors who have formed this group might well be concerned about the Sun-AT&T alliance, all this on top of IBM's being the only vendor to offer OS/2 Extended Edition, along with IBM's latest attempt to collect license fees for equipment made and sold by others as far back as 1981. But this concern seems to me to be evidence of a double standard. It's all right for IBM and Microsoft to control OS/2, these vendors seem to be saying, but Unix belongs to the world and we need to protect it and our customers from the effects of the Sun-AT&T agreement.

I don't believe AT&T will "close" Unix to the rest of the world. It would not be in AT&T's interest to do so, especially when the company is still fighting to get Unix more widely accepted. Also, there are already so many versions of Unix with so many enhancements that no one is really sure which version is which.

This industry will end up with three major "standards": OS/2, Unix, and Macintosh. Why IBM and Microsoft feel they have the right to control two of these—especially when AT&T is the "parent" of Unix in the first place—is beyond me. A Microsoft spokesperson suggested that the AT&T/Sun alliance was of concern because Sun is a hardware vendor and AT&T the systems supplier. When we asked how that was any different from a Microsoft/IBM alliance, in that one is an operating-systems supplier and the other a hardware vendor, the phone line got very quiet.

Whatever happened to marketing products on their own merit, making good old-fashioned sales efforts, and taking care of the customers? Whatever happened to the professed interest on the part of vendors in providing what's best for the end user?

It appears as if the rest of 1988 will be a time when, instead of paying attention to business, the companies in the industry will be fighting with each other. Apple versus Microsoft and Hewlett-Packard, AT&T/Sun versus the world, and IBM versus the clone makers. Who will be next?

What a waste of energy. How about if we get back to the business of providing products to meet users' needs? How about if we move one or two steps forward into the world of "group computing" and spend our time implementing the next-generation computers and software for those who are waiting in the wings to purchase (people who are willing to become computer capable but not computer literate)? If we address this as-yet-untapped market, there will be more than enough business to go around and the attorneys will be free to get back to other things. We need two Unix standards about as badly as we need yet another word processor that runs under DOS.

Advanced
MILITARY COMPUTING

Navy Dollars Flow to Neural Nets

The Office of Naval Research (ONR) plans a five-year, multimillion-dollar program for neural-net research starting in October.

Alan Meyrowitz, director of artificial intelligence for the Navy's research agency, told *Advanced Military Computing* that the first year's funding for the neural-net research would be $2 million. Four divisions of ONR will participate in the effort—those concerned with computer science, electronics, mathematics, and neurophysiology.

ONR's artificial-intelligence division contracts-out all its research. It has a budget of $6.5 million, Meyrowitz said.

"We have two primary concerns with neural nets," Meyrowitz said. "First, coupling neural nets with higher level symbolic processing (such as programs in Lisp). Second, work of a theoretical nature to find the boundaries of the potential of neural nets."

Meyrowitz said the neural-net field was too young to assign clear leadership roles to any research group. "There's not been enough time for anyone to shine," he said. Pressed to name neural-net leaders in academia, he mentioned Carver Meade of the California Institute of Technology and Jerome Feldman of the University of Rochester.

"I'm open to proposals from anyone—companies, research institutes, or universities. If the proposal is interesting, I'm free to award a contract," he said.

ONR began a five-year program in machine learning last year, funded at a higher level than the neural-net research. The program is a joint effort of the computer science and cognitive science divisions of the agency.

The machine-learning money is going to the University of Illinois in Urbana, among other places, Meyrowitz said. He was concerned with the means by which machines can acquire knowledge through inference as they solve problems.

ONR's artificial-intelligence group is also funding programs in expert systems, he added. "There still remain limits to what expert systems can do."

The Navy says robotic and distributed problem-solving applications call for more basic research in how to represent and reason about dynamic situations with many agents, each of which has its own goals, capabilities, and incomplete and uncertain knowledge of the situation.

ONR artificial-intelligence research also covers natural-language-understanding systems. The agency's research on systems for performing situation assessment covers problems such as signal interpretation, crisis alerting, information fusion, situation modeling, and inference of enemy plans with the generation of plans and counterplans.

The ultimate goal of the research is to make machines that can come close to, and possibly exceed, human abilities to perceive, learn, reason, and act on their environment.

INTELLIGENT SYSTEMS

Databases: Gateway for Expert Systems

If expert-systems technology is to be admitted into the mainstream of American business, the door through which it will pass might well be labeled "DBMS," for database-management systems. We are just beginning to see signs that business-software publishers recognize the validity of that statement.

Nowhere in business is the potential for productivity gain more apparent than in the integration of expert-systems technology into database-management systems of all kinds and sizes.

The reasons:

- databases are in use everywhere, being one of the primary uses for computing power;
- databases traditionally have been somewhat obtuse, yielding their inner secrets only to trained technical professionals, despite the fact that management personnel with little or no technical training are the "ultimate" end users;
- a huge amount of company information is stashed away in database files and could form the basis for intelligent planning and management decision-making if the inevitable patterns could be discerned;
- expert systems are information-hungry beasts that often function best in environments where knowledge abounds.

While considering that databases and knowledge bases are qualitatively different animals, it is no less true that expert systems are often used in situations where information *is* knowledge. Business has a strange way of not yielding to academic nuances.

In recent months, we have seen a number of news events take place that may be harbingers of a veritable stampede of database companies buying into expert-systems technology.

Cullinet, the giant information provider based in Westwood, Mass., purchased Distributed Management Systems Inc., developers of an expert-system tool called Impact. Cullinet is a big-league player in the mainframe-computer world. Impact, repackaged as Application/Expert (A/E), will ultimately be aimed at finding ways to weave Cullinet's database expertise with the expert-system technology of DMS and John Landry.

Lotus Development, a major publisher of desktop-computer software—including its best-selling spreadsheet, Lotus 1-2-3—formed a strategic alliance with Arity Corp. Arity is known as the publisher of what was at one time the finest Prolog compiler available for desktop computing systems. One can almost smell an intelligent spreadsheet or smart integrated software product brewing in the back rooms.

Borland International, the company that made Prolog a "mainstream" programming language with its Turbo Prolog last year, purchased Ansa Software, publisher of arguably the most powerful relational DBMS for the IBM PC and compatibles. Borland honcho Philippe Kahn has made no secret of his intent to integrate Ansa's Paradox and Borland's programming languages, including Turbo Prolog. Intelligent database systems are tangibly in the air at Borland's mountain offices near Santa Cruz, Calif.

Ashton-Tate, whose dBase product line is the runaway best-selling database program for IBM PC and compatible computers, is widely known to have a small R&D group working on an object-oriented database with built-in intelligence. The product is probably 12 to 18 months from reaching software-store shelves, but the commitment is real.

We could go on. Dozens of similar matchups are on the drawing boards of America's high-technology companies as database firms look to get a leg up on the competition and expert systems houses try to find a safe harbor in a mushy market for AI products.

It's no secret that "connectivity" has become an AI buzzword as it moves into the business world. It goes by other names—integration, embedded expert systems—but regardless of the label, the concept is usually the same. Database access, database intelligence, and data analysis are the key concepts being kicked around by the companies interested in this field.

MAD Intelligent Systems of Santa Clara, Calif., showed at AAAI87 a workstation product designed under the theory that some can be made to function better by applying expert-systems technology. With a high-grade Lisp programming environment and smart telecommunications, MAD workstations permit users to access Oracle databases on mainframe computers without the usual graduate-level understanding of how the database works.

IBM has a Lisp, Prolog and expert-system tool as part of its software arsenal already. While Big Blue has yet to make a serious commitment to AI technology as a marketing channel, it has recognized that there is something going on out here. And where are more than 80 percent of all database files stored today? You guessed it—on IBM mainframes. With IBM's recent decision to put integrated SQL (Structured Query Language) database access technology into its new line of desktops to integrate more closely with mainframe systems, the handwriting is on the wall.

Not to be overlooked is the personal-computer world, where integration and connectivity are equally important. Until very recently, most expert-system shells ignored the world of databases and were built in a virtual vacuum. Now, it seems requisite that a shell, to be accepted, must allow ease of access to existing databases. VP-Expert, from Paperback Software International, is a case in point. One of the product's main strengths is its powerful built-in instructions for obtaining information from database files and modifying it on the fly. TI's popular Personal Consultant Plus Version 2.0 has beefed-up database access, and Insight 2¢ from Level 5 (now part of Information Builders of New York) has boasted a database "engine" from its inception. The established shells without database access are scrambling to add it. Exsys' inventors, for example, showed such a product at AAAI87.

In the world of desktop computing, there is IBM and there is Apple and there are a bunch of other companies that are either IBM-compatible or too

small to notice. (Some of these IBM-compatible companies are certainly substantial, not the least of which is Compaq, but the main players are IBM and Apple Computer.) So where does Apple Computer, the second player in the desktop world, stand on AI and expert systems?

The answer, in a nutshell, is "on the sidelines." While Apple is known to have one of the most active groups in the industry looking at applying and selling AI technology, the company has been slow both to develop its own products and to cultivate third-party vendors.

Given the trend, what kind of marriages can we expect to see between databases and AI applications in the coming months? It seems clear that several classes of software could emerge, and all of them might make some showing.

First, we are already seeing AI concepts put to work in designing and implementing intelligent interfaces to database products. Database-management systems are often viewed as obtuse, hard to use, or even unfathomable by their manager-users who "just want to know how many people in Schenectady met sales quota in the last three quarters." In natural-language front ends, in adaptive interface techniques, and in helping the user sort out uncertain requests, AI has a role to play at the front end of databases.

Second, we will see more and more intelligent back ends on database systems. These will have some of the characteristics of inductive expert-system shells. They will examine information stored in databases and make some recommendations based on patterns they perceive. They will also be able to end a database session by providing not only raw data but advice and insight into managing the massive amounts of data with which managers are inundated.

Third, expect to see more expert systems and AI technology applied to reality checking in databases. Often, erroneous data can be entered into a system by an untrained person and cause unpredictable and even damaging results before the problem is detected. But a trained human expert could look at the data as it is being entered and say, "No, this won't do. Something inconsistent is going on here." This skill transcends mere data-entry editing (making sure only numbers go into numeric fields) and goes to the issue of the integrity and reality of the data. If the user puts several numbers in the wrong place so that the ultimate result is that the business is losing billions of dollars, an intelligent database system ought to be able to examine the patterns and flag the inconsistency.

Fourth, look for ES technology to become the Great Facilitator of Database Interface. Combining databases and going outside their confines to obtain information available in incompatible forms elsewhere in the environment will be among the demands placed by users on databases in the next few years. Only by the application of AI technology can these advances happen reasonably quickly.

In the final analysis, AI technology will find acceptance only to the degree that it is integrated into existing technologies. Database technology is so pervasive and sufficiently penetrable by expert-systems tools that it is the next logical mainstream software frontier for AI to tackle. The trend has started but it has yet to move into high gear.

If you are a software developer in the database world, look for AI opportunities as a way of keeping yourself a step ahead of your competition. If you are a heavy database user, start thinking about the effects of intelligent databases on your business. And start talking to your vendors about what they're planning to do to keep you at the front of the data world.

If you don't, your competition will.

Maintenance Keeps AI Software Alive

As often as this industry talks about the impending rise in deployed and delivered applications (a fact with which we agree), it has yet to talk about the next step that has to be taken after applications are finished. That next step is maintenance. Just as no one buys a new car and expects it to run without a problem for 10 years without at least some minimal sort of maintenance, no one should expect the same from artificial-intelligence applications, especially systems that are designed to "grow" with the advent of new information. These systems include expert systems.

This may be considered blasphemy in many corners, but one of the prime examples of improper maintenance planning is the icon of the expert-

system industry, Digital Equipment's XCON. Even as you read this, the system is crumpling under its own weight. This fact may not be popular in the AI industry, and we feel a little like the kid who knew the emperor had no clothes, but it signals a critical juncture in the continued use of expert systems in mainstream environments.

Begun in the early 1980s, XCON was designed with the aid of John McDermott of Carnegie-Mellon University to help DEC speed up the infinite number of configurations of its computers that went out to customers. Written in OPS5, the system was an immediate success, both inside DEC and as an example to the outside world that expert systems were real and viable.

At the time, estimates were the XCON could do in minutes what it took human configurers hours and days to do. Since then, the system has grown to somewhere between 6,000 and 9,000 rules, depending on who you talk to. It has also grown out of control.

In the past few years, maintenance changes were difficult because of the constraints of the OPS programming language. Rules were added, but the system had simply become larger instead of more efficient. The joke around DEC is that XCON originally replaced 75 people in the configuration department, but now it takes 150 just to keep it up and running.

"How can this be?" scream the masses. "XCON is everything that real expert-system work is striving for; it is proof that all AI labor is destined for commercial implementation!" Unfortunately, it is also proof that certain groups weren't looking far enough down the road at what their creations would grow into. Word has it that General Electric, in a similar vein, could no longer support and maintain its similarly infamous CAT system, which is an expert system designed for troubleshooting diesel engines on locomotives. That system has been shelved due to the company's inability to keep it adequately up to date.

The commercial world knows about maintenance, and hasn't always done the greatest job in this area either. Many huge mainframe systems that run the Cobol language are maintained using a hastily constructed code known as spaghetti Cobol. Computer analysts have been predicting that, if corporate America doesn't do something comprehensive to overhaul its spaghetti Cobol, systems will be so patched together that they won't ever be fixed at their core.

For expert systems, this is even more urgent a concern over time. Knowledge bases change according to new and evolving information. Knowledge is never static, or it becomes useless. Thus, expert systems require continual revisions to avoid quick obsolescence. Too many companies don't see past this fact, and figure that as they approach the deployment stage, their battle is over and they can watch serenely as the system goes on its merry way. This is much too much like having a hockey team practice right up until the first day of the season, and then not having any more practices at all during the year. This doesn't seem like a winning strategy.

DEC has brought in McDermott full time to oversee some changes in the XCON group. He has left his post at CMU and has resigned from Carnegie Group, which he helped found. Fixing XCON properly may involve recoding the entire package in a more maintainable form, but that has yet to be decided. For other companies, which now have the benefit of viewing DEC's efforts, planning for maintenance can come none too soon.

We'll be discussing the growing importance of maintenance in future issues. For now, the biggest question to ask is changing from "When are you going to deploy it?" to "How are you going to maintain it?"

TELECOMMUNICATIONS

INTERNATIONAL COMPUTRAN CORPORATION TEC REPORT

Sanyo to Sample IC as Anti-Wiretap Device

Sanyo Electric Co. has developed a single-chip IC device designed to prevent third parties from wiretapping or eavesdropping on wireless-telephone conversations.

The device is designed to interject signals that are synchronized with the voice signals transmitted over a phone and scramble the voice so it cannot be deciphered by the eavesdropping party. At the receiving end, a similar device restores the signal back to the original voice signals.

In 1985, Sanyo developed a similar device using a BBD element, but was unable to successfully market the device because of high cost and technical problems. The new device uses A/D and D/A converters instead of BBD and SRAM, and a time-division multiplexing method for voice and synchronizing signals to lower the cost and enhance the performance of the device.

Compared with available systems, the new IC requires only one-fourth the peripheral devices, at one-third the cost. Also, the number of scrambling keys has been increased from 32 to 128 selections. Samples are available for Y1,500 ($12) each. Potential applications are seen in cordless phones and wireless systems for police, marine, and automobile use.

FIBER OPTICS

FIBER OPTICS and COMMUNICATIONS

Waveguide Coupler Useful Over Three Modes

The United States Navy has developed a waveguide coupler that can use three or more wave modes. A copy of the patent is now available. The coupler employs two similar sections of waveguide that extend in a colinear fashion in longitudinal succession. Adjacent ends of the guide sections are spaced apart to form a gap in the boundary of the sections. A third section is disposed external to and coaxial with at least a part of each of the two waveguide sections. This arrangement provides a boundary surrounding the gap.

Electromagnetic energy propagating down one of the two similar sections of waveguide in a first mode and entering the gap is converted partly to a plurality of other modes. The converted energy is reconverted to the first mode upon reaching the other of the two similar sections of waveguide. The electric field pattern exciting the section of waveguide at the end of the gap and propagating down it is exclusively in the first mode.

The dimensions of the third section of waveguide provide a determination of the cutoff. These dimensions, along with the gap separation, are determined from the condition that the phase relationships between the modes at the end of the gap be the same, to within an integral multiple of 2 pi, as what they were at the beginning of the gap. This condition ensures complete power transfer between the two similar sections of waveguide.

Fiber Optics News

Bellcore Demonstrates Fast All-Optical Switching

Bellcore scientists have demonstrated the feasibility of an all-optical device capable of switching laser pulses between channels inside a strand of optical fiber at speeds of 1/10 of a picosecond. "We think this device is one of the most promising configurations for all-optical switching," said Peter Smith, Bellcore researcher at the Navesink Research and Engineering Center. "By using the capabilities of all-optical switching, we will be able to come closer to realizing the enormous capacity of the fiber-transmission medium."

Smith, assisted by researchers Stephen Friberg, Yaron Silberberg, and Andy Weiner, demonstrated the first and fastest application of a theoretical proposal. The light signal from the device can be made to switch from one optical channel to another by varying the intensity of the light itself.

The device consists of a segment of non-linear fiber with two cores. Varying the intensity of the incident light signal frustrates coupling of the two cores, and the output core switches from one optical channel to another. Light pulses can be generated that are thousands of times faster than electronic signals, so the all-optical switch can work thousands of times faster than any electronic counterpart.

Previous all-optical switching devices suffer from heating problems caused by light absorption, and have limited operation to low switching rates. Bellcore's device is built entirely of highly transparent glass and has eliminated thermal problems. "The demonstration represents the fact that we've reached an important milestone with this device," said Silberberg. "But the whole concept must be further developed. It's only one element of future systems, although it seems clear that this non-linear optic technology will introduce switching at high speeds."

Corning France Targets Optical LANs

Corning France S.A. has developed a technique for integrating optical waveguides in a glass substrate using photolithography and ion exchange. The company has already started marketing a line of components with a capability of mass producing high-performance branching devices used in optical-fiber local-area networks (LANs).

Until now, only two techniques have been used to fabricate optical branching devices such as couplers and wavelength-division multiplexers. In one, fibers are either fused or polished and cemented. The other technique, used for micro-optic systems, aligns and assembles discrete optical components such as lenses and beam splitters.

The first Photocor products were tree couplers, with variants branching from one fiber to two, three, four, six, eight, 16, or 32 fibers. Insertion loss is low, ranging from 3.5 decibels for the one-by-two coupler to 17 decibels for the one-by-32 device. These figures represent excess losses of only 0.5 decibels and two decibels, respectively.

The Corning France products are 8-by-8, 16-by-16, and 32-by-32 star couplers, and a wavelength-division multiplexer for 850-nm and 1,300-nm wavelengths.

The MGM 1385 wavelength-division multiplexer will combine or separate two wavelengths of light in the region of 850 nm and 1,300 nm. The two wavelengths can be multiplexed onto a single fiber or separated into two fibers, each carrying a different wavelength.

The device therefore allows bidirectional communication on one fiber, or the doubling of capacity on a directional link. Excess loss is below 1.5 decibels, and at the same time isolation is better than 25 decibels. Custom design permits other wavelengths as well.

MANUFACTURING AUTOMATION

Software Manages Engineering Data

Engineering data management constitutes a major problem for many companies. Solving the problem, even with the best commercial products, appears to require significant time, effort, and funding. One vendor, Sherpa Corp. of San Jose, Calif., has developed a system that allows companies to build and test a small system before committing to large-scale implementation.

Called QuickStart, this starter kit is designed for an eight-week implementation. It includes a license for Sherpa's Engineering Data Management (EDM) software, which is an application template for documentation control that should be 80 percent complete; Sherpa personnel complete the remaining 20 percent, and training. The cost is $29,900 for five users and $48,500 for ten users. According to a survey Sherpa cites, this compares to a typical full-system implementation investment of $350,000 and two man/years of work. In fact, that investment sounds low to us.

It makes sense to set up a pilot for a system that can be that large. Beginning small is even more important, because product data management systems change procedures and organizational reporting structures radically. Like many integration systems, configuration management systems may have ripple effects throughout a company that become clear only when a pilot system is installed.

Sherpa was the first company not in the CAD business to offer an engineering data management product. The system handles diverse databases. Although the company currently sells software for managing product data (CAD and manual), the architecture will allow adding many other types of data to the system.

Sherpa also differs from many others in this market, in that it provides source code for companies to customize the system. In addition, companies can buy software for building an appropriately tailored user interface.

In conjunction with Market Reach, Sherpa conducted market research among large companies (over $50 million annual revenues, over $1 million invested in CAD/CAM/CAE, and over 100 engineers) about engineering data management. The results are interesting, though not startling. Only 11

percent feel they have a solution for product data management; another 25 percent are evaluating options. Half now see the need and are allocating resources to study engineering data management.

One interesting question involves the cost of problems caused by a lack of such a system. The answers came back that poor product data management can add costs of 23 percent in scrap and/or rework, 22 percent in late designs, and 18 percent in wasted personnel time.

Flexible Automation

GM's Expert System Diagnoses Troubled Machines

Charlie Amble was General Motors' best machine diagnostician. Charlie now spends most of his days playing golf, but continues to save GM $1 million a year with his analyses to pinpoint machine problems. His expertise is embedded in an expert system, Project Charlie, which has a batting average of about 95 to 98 percent accuracy. Project Charlie has diagnosed problems including a rare case of drive-shaft imbalance and a coupling misalignment of 0.007 inches.

Use of the expert system requires the input of certain information: GM's identification number for the machine, vibration signatures taken at various parts of the machine, and a description of details such as the number of teeth on gears. Armed with such input, the program guides a maintenance worker through the steps of machine diagnosis.

GM is considering selling Project Charlie as a product, but no decision has yet been made. The company is also considering extending the technique into the diagnosis of machines with reciprocating components. In time, diagnosis may go on-line. Sensors on the machine would then relay vibration patterns back to the expert diagnostic system to keep continuous track of a machine's condition.

New Products

OFFICE PRODUCTS

Nefax 3EX fax system. Acts as a Group 3 facsimile machine, telephone, answering machine, and copier. The system's telephone offers automatic redial and stores as many as 50 speed-dial numbers; the answering machine uses microchip storage. The compact system includes a 9,600-bit/second modem and weighs 16 lbs. $2,395. NEC America Inc., Facsimile Division, 8 Old Sod Farm Rd., Melville, NY 11747. (800) 782-7329; in N.Y., (516) 753-7406. *Circle 1.*

4020 plotter cover. This acoustical cover for the Hewlett-Packard Model 7475 and other plotters incorporates a foam-plastic base, a high-impact top, internal foam, and a tinted styrene viewing window. Printer paper moves through a 13½-inch-wide front slot and an 18-inch slot at the rear. $159.95. An optional fan is available for $69.95. Micro-Computer Accessories Inc., Box 66911, Los Angeles, CA 90066. (800) 521-8270; in Calif., (213) 301-9400. *Circle 2.*

5R home-business software. A financial record keeper that handles payroll, accounts aging and billing, perpetual inventory, 1099 and W-2 forms, P/L statements, balance sheets, and depreciation. Users can define security passwords. The software runs on MS-DOS or OS/2 systems that have at least 256 kilobytes of memory. $595. 5R Inc., Box 401, Tujunga, CA 91042. (818) 352-8020. *Circle 3.*

Access 4.2 messaging software. Lets users transfer calls or use a voice mailbox to keep messages. Features directory assistance; can play music or announcements while callers are on hold. Users can add a voice mailbox. $20,000 to $250,000. Boston Technology, 1 Kendall Square, Cambridge, MA 02139. (800) 333-3678; in Mass., (617) 225-0500. *Circle 4.*

ADR/eMAIL scheduling software. This electronic-mail software plans meetings, automatically considering time zones. If a conflict develops, the system finds alternative times, reschedules, and marks cancellations. Comes with a digitized voice-support system for touch-tone phones. $21,500 to $36,800. Applied Data Research Inc., Route 206 and Orchard Rd., CN-8, Princeton, NJ 08543. (201) 874-9000. *Circle 5.*

DVX-II voice-mail system. Records, stores, transmits, distributes, and retrieves digitized voice messages from touch-tone phones. Various models accommodate 500 to 3,000 subscribers. The system works with most PBXs and offers voice-controlled transcription and digital networking. $25,000 (for two ports and three hours of storage) to $176,000 (for 20 ports and 126 hours of storage). Wang Information Services Corp., 1 Industrial Ave., M.S. 019B7A, Lowell, MA 01851. (800) 835-9472. *Circle 6.*

ET 2000 typewriters. Four electronic models made for heavy office work. Features include automatic paper handling, quiet operation, four letter-spacing options, and a 500-character correction memory. The high-end Model 2400 can operate as a 20-character/second printer and has an adjustable keyboard. $549 to $899. Olivetti U.S.A., Office Products Division, 765 U.S. Highway 202, Somerville, NJ 08876. (201) 526-8200. *Circle 7.*

Laser Desk computer desk. This steel desk holds all the parts of a personal-computer system. A pull-out shelf accommodates Hewlett-Packard LaserJet or Apple LaserWriter printers. Another shelf above the printer holds a central-processing unit, a roll-out platform hides the keyboard, and an adjustable arm above the desktop supports the display. $399. Global Computer Supplies, 45 S. Service Rd., Plainview, NY 11803. (800) 845-6225. *Circle 8.*

Limelight-7 computer projector. Displays a 4- to 12-inch diagonal image showing whatever appears on a computer screen. The projector connects to most personal computers through a cable into any composite video, RGB-TTL, or RGB-analog port. Resolution is 800×600 pixels. $2,995. Vivid Systems Inc., 41752 Christy St., Fremont, CA 94538. (800) 331-2834; in Calif., (415) 656-9965. *Circle 9.*

PA-302 network analyzer. A laptop unit that collects, records, and analyzes data on Ethernet-based local-area networks to monitor real-time performance. The analyzer, built into a Toshiba computer, supports all seven layers of the OSI Reference model and works with all popular Ethernet protocol models. $15,000. Network General Corp., 1945A Charleston Rd., Mountain View, CA 94043. (415) 965-1800. *Circle 10.*

PC-6 compact copier. Offers automatic exposure; prints in black, brown, blue, red, or green by using interchangeable toner cartridges. The copier handles standard and legal-size paper from originals as large as 8½×14 inches. It includes a 100-sheet paper cassette. The system measures about 10×20×18 inches. $1,495. A 3,000-copy black toner cartridge is available for $144.95; color cartridges cost $99.95 each. Canon U.S.A., 1 Canon Plaza, Lake Success, NY 11042. (800) 652-2666; in N.Y., (212) 688-1200. *Circle 11.*

PC Yellow Pages program. This MS-DOS/PC-DOS software lists toll-free phone numbers, company names, addresses, and zip codes for 10,000 businesses. Also lists 5,000 local business numbers in each U.S. area code. The program lets users dial numbers by business name or category. $99.99. Specific-category programs cost $39 for 1,500 names, $99 for 3,000 names. Digital Publications Inc., 5390 Peachtree Industrial Blvd., Suite 105, Norcross, GA 30071. (800) 777-1470; in Ga., (404) 448-6881. *Circle 12.*

Platinum Reference DB2 manual. A pocket-sized reference for data-processing professionals using DB2 and QMF. Provides SQL commands, predicates, data types, DB2 utilities, and systems tables, including SQL return codes. $15. Platinum Technology Inc., 555 Waters Edge Dr., Lombard, IL 60148. (800) 442-6861; in Ill., (312) 620-5000. *Circle 13.*

TI-5021 calculator. Has a 12-digit liquid-crystal display; calculates percentages and offers a four-key memory, a margin up/down key for computing prices, and a shift key to simplify corrections. Runs off a AA battery. Measures about 6×7×2 inches. $35. Texas Instruments, Consumer Relations, Box 53, Lubbock, TX 79408. (806) 747-1882. *Circle 14.*

VMX Manager network software. A personal-computer-based package that manages single and multiple VMX systems. It analyzes and reports calls or user-transaction data used in billing, accounting, or other administrative functions. Also handles traffic data from the VMX database and updates database deletions. $15,000. VMX Inc., 17217 Waterview Parkway, Dallas, TX 75252. (800) 843-5399; in Tex., (214) 907-3000. *Circle 15.*

■ COMPUTER HARDWARE

Cardinal VGA color monitor. This 14-inch monitor supports all Video Graphics Array functions and has a palette of 256,000 colors. Offers a 0.31-millimeter dot pitch and an internal power supply that operates anywhere in the world. $699. Cardinal Technologies Inc., 1827 Freedom Rd., Lancaster, PA 17601. (717) 293-3000. *Circle 16.*

FlexCache 20386DT computers. Two 20-megahertz, 80386-based machines with one megabyte of memory and 32 kilobytes of cache memory. The systems provide a 40- or 66-megabyte hard disk, a 1.2-megabyte 3½-inch floppy-disk drive, and one serial and one parallel port. Model 401 costs $4,490; Model R66 is $4,590. Advanced Logic Research Inc., 10 Chrysler, Irvine, CA 92718. (714) 581-6770. *Circle 17.*

Intersect CDR-80 CD-ROM drive. Fits in the floppy-drive slot of the IBM PC/XT/AT and compatible computers; also works with IBM PS/2s with a standard 5¼-inch mount. The half-height drive accepts disks in IBM High Sierra, Macintosh HFS, and ISO 9660 formats. $899; interface kits cost $199. NEC Home Electronics Inc., 1255 Michael Dr., Wood Dale, IL 60191. (312) 860-9500. *Circle 18.*

Loop 286 personal computer. An 80286-based, 12.5-megahertz computer with 640 kilobytes of memory, a 1.2-megabyte floppy-disk drive, and four expansion slots. Includes two serial ports and one parallel port, plus Enhanced Graphic Adapter compatibility. $1,699. Focus Technology, 18226 W. McDurmott, Irvine, CA 92714. (800) 852-0105; in Calif., (714) 553-8626. *Circle 19.*

MB2400EX desktop modem. Compatible with the Hayes AT command set. The modem communicates at 2,400 bits/second and has a 25-pin RS-232C port and two switched phone jacks. Front-panel lights show transmission status. $299. Cardinal Technologies Inc., 1827 Freedom Rd., Lancaster, PA 17601. (717) 293-3000. *Circle 20.*

Model 5080 tape backup. A SCSI-compatible system that holds 80 megabytes of data from Apple Macintosh computers on one DC 2000 minicartridge. Allows data transfer from Macintoshes to the IBM PS/2

and other personal computers. Comes with software and 256 kilobytes of cache memory. $1,695. Irwin Magnetic Systems Inc., 2101 Commonwealth Blvd., Ann Arbor, MI 48105. (313) 996-3300. *Circle 21.*

Multiport/2 enhancement board. Provides eight serial ports for IBM PS/2 Model 50, 60, and 80 computers. Four boards can be installed in one computer. The board supports a variety of multiuser operating systems, including Xenix, Unix, Pick, and Theos. $995. Arnet Corp., 618 Grassmere Park Dr., Nashville, TN 37211. (800) 366-8844; in Tenn., (615) 834-5222. *Circle 22.*

Omnimouse computer mouse. Offers 200-dot/inch resolution; works with the IBM PC/XT/AT, PS/2, and compatible computers. Supports drivers for Mouse Systems and Microsoft protocols. $89. MSC Technologies Inc., 2600 San Tomas Expressway, Santa Clara, CA 95051. (408) 988-0211. *Circle 23.*

PC20-III personal computer. An 8088-based machine with 640 kilobytes of random-access memory, a 360-kilobyte 5¼-inch floppy drive, and a 20-megabyte hard disk. Has built-in graphics adapters, video and mouse interfaces, and parallel and serial ports. $1,499. Commodore Business Machines Inc., 1200 Wilson Dr., West Chester, PA 19380. (215) 431-9100. *Circle 24.*

PowerMate 386/20 computer. This 80386-based IBM-compatible personal computer runs at 20 megahertz. Its two megabytes of random-access memory can be expanded to 16 megabytes. The system also has a 42-megabyte hard disk and a 1.2- or 1.4-megabyte floppy-disk drive. $5,795. NEC Information Systems Inc., 1414 Massachusetts Ave., Boxborough, MA 01719. (508) 264-8000. *Circle 25.*

Premium/386 3320 computer. A 20-megahertz, 80386-based system with a 320-megabyte hard disk and two megabytes of memory. Includes a 1.2-megabyte, 5¼-inch floppy-disk drive. Offers three selectable speeds and seven expansion slots. $10,795. AST Research Inc., 2121 Alton Ave., Irvine, CA 92714. (714) 863-9991. *Circle 26.*

PS/2 Model 50-Z computer. Uses an 80286 processor. The 10-megahertz system has one megabyte of memory, a 30-megabyte hard disk, and a 1.44-megabyte 3½-inch disk drive. Offers serial, parallel, and mouse ports, Video Graphics Array compatibility, and three expansion slots. $3,995. IBM Corp., U.S. Marketing and Services Group, 900 King St., Rye Brook, NY 10573. (914) 934-4000. *Circle 27.*

PS/2 Model 70-A21 computer. This 80386-based, 25-megahertz system provides two megabytes of random-access memory, 64 kilobytes of cache memory, a 120-megabyte hard disk, and a 1.44-megabyte 3½-inch disk drive. Has serial, parallel, and mouse ports, Video Graphic Array compatibility, and three expansion slots. $11,295. IBM Corp., U.S. Marketing and Services Group, 900 King St., Rye Brook, NY 10573. (914) 934-4000. *Circle 28.*

QuadPort PS/Q board. An input/output board that equips IBM PS/2 Model 50 and 60 computers with two RS-232C serial ports. The board works with DOS, OS/2, Xenix, and Unix operating systems. $295. Quadram, 1 Quad Way, Norcross, GA 30093. (404) 923-6666. *Circle 29.*

Smartscan color monitor. This 14-inch monitor supports all Video Graphics Array functions with a resolution of 800×600 pixels. It has a 15- to 35-kilohertz scanning rate, a 0.31-millimeter dot pitch, and a tilt-and-swivel base. $795. Amdek Corp., 1901 Zanker Rd., San Jose, CA 95112. (408) 436-8570. *Circle 30.*

Speedcard accelerator board. Doubles the speed of a Macintosh SE computer. The 16-megahertz card holds a Motorola 68000 microprocessor, a 16-kilobyte hardware random-access memory cache, and a 16-bit peripheral port that reproduces the SE's expansion bus. A math coprocessor is optional. $399. SuperMac Technology, 295 North Bernardo Ave., Mountain View, CA 94043. (415) 964-8884. *Circle 31.*

VGA/20 color monitor. A 20-inch display that offers 1,024×786-pixel resolution with 256 colors. Has an anti-glare screen and a tilt-and-swivel base. Works with many third-party Video Graphics Array cards. $2,545. Aydin Controls, 414 Commerce Dr., Fort Washington, PA 19034. (800) 366-8889; in Pa., (215) 542-7800. *Circle 32.*

VGA Plus graphics board. Lets IBM-compatible computers display text and graphics in color or monochrome on analog monitors. The 16-bit board offers variable resolutions: 640×480 pixels with 256 colors, 800×600 pixels with 16 colors, or 720×400 pixels in monochrome text mode. Also displays 132-column text. $599. AST Research Inc., 2121 Alton Ave., Irvine, CA 92714. (714) 863-9991. *Circle 33.*

Viking 2400 color monitor. A 24-inch monitor for the IBM PC/AT and PS/2 Model 50, 60, and 80 personal computers. Resolution is 1,280×960 pixels. The display supports most computer-aided-design and desktop-publishing programs. $2,995. Moniterm Corp., 5740 Green Circle Dr., Minnetonka, MN 55343. (612) 935-4151. *Circle 34.*

Z-286 LP personal computer. This 17-lb. unit measures only 3.9×14×15 inches but includes a 40-megabyte hard disk, one megabyte of random-access memory (including 256 kilobytes of Expanded Memory

Specification), a 1.44-megabyte floppy-disk drive, two serial and one parallel port, and a PC/XT-style keyboard. $3,999. Zenith Data Systems, 1000 Milwaukee Ave., Glenview, IL 60025. (312) 699-4839. *Circle 35.*

COMPUTER SOFTWARE

Act III presentation designer. Helps create computer-based presentations such as interactive slide shows, training programs, and advertising productions. The software offers word processing, painting, animation, and music capabilities. Runs on IBM-compatible computers that have 256 kilobytes of memory and a mouse. $299. Informatics Group Inc., 80 Shield St., West Hartford, CT 06110. (203) 724-4040. *Circle 36.*

Compusec portfolio manager. This software handles stocks, bonds, and other property. It gets quotes from a Dow Jones database and calculates the unrealized gain or loss on holdings, as well as the realized gain or loss on securities sold. Also computes compound rates of growth per share. Runs on Apple computers. $79.50. Compunetics Inc., 6601 River Rd., Bethesda, MD 20817. (301) 320-5820. *Circle 37.*

FastBack Plus hard-disk backup. Version 1.01 compresses data and uses error-correction functions to tolerate as much as 13 percent damage to a backup diskette. The software reads the hard disk and writes the data to floppy disks simultaneously to copy about three megabytes per minute. Works with floppies, tape drives, Bernoulli cartridges, and external hard disks. For IBM-compatible computers. $189. Fifth Generation Systems Inc., 1322 Bell Ave., Suite 1A, Tustin, CA 92680. (800) 225-2775; in Calif., (714) 259-0541. *Circle 38.*

ReadRight International scanner. This software reads text in American and British English, Canadian and Continental French, German, Italian, Spanish, Swedish, Dutch, Danish, and Norwegian. Works with Canon, Hewlett-Packard, Microtek, AST Research, and Taxan scanners. $595 for English; $895 for other languages. OCR Systems Inc., 1800 Byberry Rd., Suite 1405, Huntingdon Valley, PA 19006. (215) 938-7460. *Circle 39.*

SearchExpress text finder. Searches through text, desktop-publishing, image, and computer-aided design/manufacturing files for specific words, phrases, or drawings. The program displays and prints whole documents, paragraphs, or sentences. Runs on Lanier personal workstations, and on the IBM PC and compatible computers with 640 kilobytes of memory and a 20-megabyte hard disk. From $349. Lanier Business Systems, 1700 Chantilly Dr. N.E., Atlanta, GA 30324. (404) 329-8000. *Circle 40.*

Vaccine data protector. These three programs detect "viruses" that may invade a computer and damage data. Vaccine, a resident program, automatically checks every program in memory. The Antidote utility scans the hard disk for any known viruses, and the Checkup program alerts users if any executable files (.EXE and .COM files) have been changed. Runs on IBM-compatible computers. $79.95. WorldWide Data Corp., 17 Battery Place, New York, NY 10004. (212) 422-4100. *Circle 41.*

Vectr travel-expense manager. Helps review and organize payments, travel history, and reconciliation. The program manages a master file and transmits payment information directly to a bank. Allows file transfer from the Vectr database to Lotus 1-2-3, dBase, or RBase. Runs on IBM-compatible computers with 256 kilobytes of memory. $295. Gelco Payment Systems, 1 Gelco Dr., Eden Prairie, MN 55344. (800) 334-3526, in Minn., (612) 828-2236. *Circle 42.*

COMMERCIAL/INDUSTRIAL

1800 VA portable power source. A standby system that provides 4 to 10 minutes of power for electronic equipment when line power fails. The system switches to battery power in half a cycle when line voltage drops below −15 percent of the nominal level, sounding an alarm. Runs on 120-volt, 60-hertz input; plugs into standard AC electrical outlets. The power source guards against transients and also prevents damage from short-circuits or overloads. $1,899. Sola, 1717 Busse Rd., Elk Grove Village, IL 60007. (312) 439-2800. *Circle 43.*

6400A voltage standard. Delivers AC voltages from 1 nanovolt to 1,000 volts with an amplitude uncertainty of no more than 32 parts per million between 40 hertz and 20 kilohertz. The instrument produces sine waves between 10 hertz and 1 megahertz. Amplitude precision is 1 part per million. Seven ranges span 1 millivolt to 1,000 volts. $12,000. Ballantine Laboratories Inc., Box 97, Boonton, NJ 07005. (201) 335-0900. *Circle 44.*

Cals PeakPro chromatograph software. Acquires and analyzes data from both gas and liquid chromatographs. The menu-driven program plots information as it is obtained and maintains an event log. Analog outputs from the instruments go to a DEC VAX computer through an RS-232C port. From $15,000. Beckman Instruments Inc., Laboratory Automation Operations, 160 Hopper Ave., Waldwick, NJ 07463. (201) 444-8900. *Circle 45.*

Ethernet line monitor. Directly measures signals on Ethernet transceiver cables; indirectly measures signals on coaxial cables. The monitor mounts on the AUI cable and needs no external power. Comes with cable and connectors to plug into networks. $145. Black Box Corp., Box 12800, Pittsburgh, PA 15241. (412) 746-5500. *Circle 46.*

GrowthPower lot-control software. Lets manufacturers assign each part a lot or serial number of up to 20 characters, then track lots, work orders, general-ledger codes, and sales orders. Runs on Hewlett-Packard 3000 minicomputers. $15,000 to $25,000. Computer Solutions, 1 Burlington Woods, Burlington, MA 01803. (617) 229-2200. *Circle 47.*

HP 35660A signal analyzer. This two-channel unit performs spectrum analysis from DC to 102.4 kilohertz and network analysis from DC to 51.2 kilohertz. Both channels have 400-line resolution. The analyzer measures linear spectrum, power spectrum, frequency response gain/phase, group delay, time history, and power spectral density. Includes a 3½-inch disk drive; compatible with HP 9000 Series 200/300 workstations. $12,500. Hewlett-Packard Co., 19310 Pruneridge Ave., Cupertino, CA 95014. Call local sales office. *Circle 48.*

Java video-analysis software. Measures and analyzes video images from any common composite source, including cameras and videocassette recorders. Also accepts many pre-digitized images, including magnetic-resonance imaging and ultrasound. The software performs densitometry, morphometric analysis, and automatic line and edge digitizing. Supports several commercial video-digitizing boards. $795. Jandel Scientific, 65 Koch Rd., Corte Madera, CA 94925. (415) 924-8640. *Circle 49.*

LCG-413 test-pattern generator. A video tester with a four-digit alphanumeric source identifier, a white raster, full-field color bars, and a 0-dBm balanced audio output at 400 and 1,000 hertz. The device can clip onto a waveform monitor and vectorscope for portable testing. $1,415. Leader Instruments Corp., 380 Oser Ave., Hauppauge, NY 11788. (516) 231-6900. *Circle 50.*

System 7000 signal processor. Accepts signals from a large number of processors simultaneously. The parallel unit analyzes vibration and stress with 528 channels of analog data, each reaching 375,000 samples/second. Handles data at 13.2 million samples/second. Runs on DEC VAX, HP-9000, or IBM PC computers. A 24-channel system costs $81,000. Zonic Corp., 2000 Ford Circle, Milford, OH 45150. (513) 248-1911. *Circle 51.*

SDE/Science supercomputer tools. This software helps write programs or convert VAX programs to run on Cray supercomputers. Has guidelines for writing code in Cray Fortran 77 and 1.15, and Cray C. Works with VAX processors. $15,503. Digital Equipment, 146 Main St., Maynard, MA 01754. (508) 897-5111. *Circle 52.*

CONSUMER PRODUCTS

RoomMate II portable speakers. These speakers work with a Walkman, compact-disc player, computer, or electronic keyboard. They have an AC/DC power jack and a removable AC power cord. Features include a two-stage equalization network, distortion-limiting circuitry, and a dual-channel amplifier. Each speaker measures 7×10×7 inches. $279; a 12-hour battery pack costs $89.95. Bose Corp., The Mountain, Framingham, MA 01701. (508) 879-7330. *Circle 53.*

550 remote-control speakers. Each pair produces 1,400 watts. A remote controller adjusts the five amplifiers in each speaker to adapt to various acoustical environments and listener preferences. $12,000 per pair. Altec Lansing, Milford, PA 18337. (717) 296-6444. *Circle 54.*

6010 answering machine. Records outgoing and incoming messages on one microcassette. The machine incorporates a telephone and comes with a beeperless remote unit. A call monitor screens incoming calls; for privacy, users can listen to incoming messages through the telephone handset. $109.95. GTE Consumer Communications Products Corp., 30 Buxton Farms Rd., Stamford, CT 06905. (800) 633-2076. *Circle 55.*

7520/7510 answering machines. Both models incorporate a telephone and offer digital voice recording instead of an outgoing-message cassette. Model 7520 offers a beeperless remote unit to play back messages, a call monitor to screen calls, and a message interrupt that lets users answer a call after the machine is activated. Model 7510 has a one-touch memory, last-number redialing, tone/pulse dialing, and a pause feature. $189.95 and $149.95, respectively. GTE Consumer Communications Products Corp., 30 Buxton Farms Rd., Stamford, CT 06905. (800) 633-2076. *Circle 56.*

9000 security system. This wireless system has a voice that guides users through its operation and testing, reports which sensor triggered an alarm, and utters other requests and messages. The system is about the size of a phone-answering machine. An automatic dialer can call eight numbers and relay a taped emergency message in the user's voice. Options include remote controls, infrared motion detectors, and smoke alarms. $494. Dicon Systems Inc., 631 Executive Dr., Willowbrook, IL 60521. (800) 387-2868. *Circle 57.*

Acoustimass speakers. The SE-5 speaker system delivers the power, bass, range, and spatial accuracy of a large speaker system, yet the 20-lb. system measures only 8×12×20 inches. The 10.2 Series II speakers produce stable sound and deep bass evenly throughout a room. They use a three-driver targeting array, an 8-inch midrange driver, and two 2-inch tweeters. The SE-5 costs $699; the 10.2, $1,299 per pair. Bose Corp., The Mountain, Framingham, MA 01701. (508) 879-7330. *Circle 58.*

CDC-610U compact-disc changer. Handles 10 discs at a time, with programmable 24-track random selection. A program can be interrupted to add selections; discs can play consecutively for 10 hours of uninterrupted music. The device includes an 8-digit display and a 27-key infrared remote controller. $599. Yamaha Electronics, 6660 Orangethorpe Ave., Buena Park, CA 90620. (800) 492-6242. *Circle 59.*

DX-1500/2500 compact-disc players. Both models show the playing sequence of 16 tracks that can be programmed in random order. The DX-2500 adds fixed analog and digital output terminals and a direct-play feature that skips to the beginning of any track. $260 and $320, respectively. Onkyo USA Corp., 200 Williams Dr., Ramsey, NJ 07446. (201) 825-7950. *Circle 60.*

EQ-540 graphic equalizer. A 24-band machine with a built-in test-frequency generator, independent left- and right-channel adjustments, and a microphone. The equalizer includes 12 pairs of controls and covers 16 hertz to 32 kilohertz. $400. Onkyo USA Corp., 200 Williams Dr., Ramsey, NJ 07446. (201) 825-7950. *Circle 61.*

Kitchenmate/Walkmate telephones. Two portable models: The Kitchenmate stores 13 numbers and offers redial and paging. The Walkmate offers a 20-number one-touch memory, one-touch redial, and hold. $114.95 and $139.95, respectively. GTE Consumer Communications Products, 30 Buxton Farms Rd., Stamford, CT 06905. (800) 633-2076. *Circle 62.*

TX-1000U stereo tuner. This AM/FM tuner offers selectable antenna inputs and wireless remote control. Digital fine-tuning locates the best possible signal regardless of interference. The tuner also has a 24-station preset memory, station display, and a signal-quality meter. $549. Yamaha Electronics, 6660 Orangethorpe Ave., Buena Park, CA 90620. (800) 492-6242. *Circle 63.*

GET THE EDGE

In case you missed any of these stories when they appeared in HIGH TECHNOLOGY BUSINESS, here is a selected listing from the past year. Check the stories you want and fill in the form. Include $5 for each story to cover photocopying, postage, and handling.

BOOK REVIEWS

- ☐ Escaping the Paradigm
- ☐ The High-Tech Bookshelf

COMPANY PROFILES/ INTERVIEWS

- ☐ Aian
- ☐ Alcoa
- ☐ AT&T
- ☐ Cheyenne Saftware
- ☐ Digital Equipment
- ☐ Dow
- ☐ Endogen
- ☐ GM
- ☐ GTX
- ☐ Healthdyne
- ☐ LISSA
- ☐ Lockheed
- ☐ Mentar Graphics
- ☐ NCR
- ☐ On Technology
- ☐ Presidential Adviser William Graham
- ☐ Prime
- ☐ Siemens Capital
- ☐ TRW
- ☐ Vayager
- ☐ Xerax

COMPUTERS

- ☐ Accounting far Autamatian
- ☐ Apple's Carporate Image
- ☐ Caution: Slaw Grawth Ahead
- ☐ Clash af the High-Speed Titans
- ☐ Compact-Disc Campanies Test New Frantier
- ☐ Computers Invade the Executive Suite
- ☐ Designware Leader Faces New Threat
- ☐ Eurape's Barriers Crumble
- ☐ Fax Makers Target Law-End Market
- ☐ Looking Good an Paper
- ☐ Latus at Risk
- ☐ Making Cautiaus Changes
- ☐ Netwarks Get Dawn ta Business
- ☐ Rethinking Artificial Intelligence
- ☐ RISC-y Business

CONSUMER

- ☐ Camcarder Campanies Divvy Up a Bewildered Market
- ☐ Hame, Safe, Hame
- ☐ IBM Opens the Door far Entrepreneurs
- ☐ Interactive TV Opens New Retail Market
- ☐ Lattery Machines Bet On Overseas Success
- ☐ Maney Machines Outgrow Banking
- ☐ Mare Schooling far Tamarrow's Engineers?
- ☐ New Pagers Put a Mailbax in Yaur Pocket
- ☐ Office Aids far Executives
- ☐ Smart Cards Get Smarter
- ☐ TV: The Push far a Sharper Picture

INDUSTRIAL

- ☐ 19BB's Hattest Superconducting Campanies
- ☐ America's Technalagy Champians
- ☐ Biatech Targets Fight Back
- ☐ Business TV Becames Big Business
- ☐ Cash Crisis Creates Biatech Alliances
- ☐ Campanies Prafit Fram Saunds af Silence
- ☐ Campanies Turn Ideas Inta Prafits
- ☐ Industrial Adhesives Start ta Spread
- ☐ Mobile Phanes Mave Fram Cars to Pockets
- ☐ Optical Memaries Vie far Data Starage
- ☐ Picking Up the Pieces af RCA
- ☐ Plastics Makers Clean Up From Litter
- ☐ The Rewiring af America
- ☐ Where Venture Capital Is Investing Naw

JAPAN WATCH

- ☐ A New Look in Mainframes
- ☐ Assembly Lines Build Ideas
- ☐ Memary Far Micrawaves
- ☐ NTT Squanders a Lead
- ☐ On the Bialagical Frantier
- ☐ Phatas Ga Electranic
- ☐ Prefab Hauses Mave Upscale
- ☐ Smart-House Standards
- ☐ Supercanductar Strides

MEDICAL

- ☐ AIDS Crisis Spurs Hunt far New Tests
- ☐ Better Drug Packaging Thwarts Saboteurs
- ☐ Biatech Firms Cultivate Cell Market
- ☐ Building a Better Bite
- ☐ Card Manitars X-Ray Expasure
- ☐ CT Scanners Seek Out Manufacturing Flaws
- ☐ Harvesting the Cell
- ☐ Herpes DNA Probe is Nanradioactive
- ☐ Medical Pumps: Smaller and Mare Efficient
- ☐ New Methods Deliver Medicine & Prafits
- ☐ Shakeout Looms in Medical Scanners
- ☐ Trials of a Cancer Drug
- ☐ The Race After Genentech

MILITARY/AEROSPACE

- ☐ Air Reservatians: New Savvy in the Skies
- ☐ Defense Cantractars Target Electronics
- ☐ Equipment Makers Prafit From Safer Space
- ☐ Little Giants Win Space-Plane Cantracts
- ☐ Military Saftware's New Market
- ☐ Pentagan Sees Infrared
- ☐ The Venerable Airship Bounces Back
- ☐ Space Statian Business
- ☐ Space Business an the Rise
- ☐ Star Wars: Where the Maney's Going

SUCCESS STORIES

- ☐ Connecting

THE LAW

- ☐ Competitars Team Up
- ☐ Capyrighting Technalagy
- ☐ Exports: Handle With Care
- ☐ Eyes in the Sky
- ☐ Investars Gain Claut
- ☐ Let the Buyer Beware
- ☐ Making it Overseas
- ☐ Patents Safeguard Saftware
- ☐ Patents vs. Public Interest

HIGH TECHNOLOGY BUSINESS

Name: _____

Address: _____

City/State: _____

Zip: _____

Mail to: Get the Edge
High Technology Business
214 Lewis Wharf
Boston, MA 02110

No. Stories _____
$5 each _____
Total Enclosed _____

MARKETWATCH

NEW COMPANIES

COMPANY	BUSINESS OBJECTIVE	FINANCING	OFFICERS	OFFICERS' PREVIOUS POSTS
Advonced Grophics 6225 Cochran Rd. Solon, OH 44139 (216) 349-0600	To develop high-performance graphics equipment for IBM-compatible, B03B6-based personol computers.	Wholly owned subsidiary of Tecmar Inc.	Gary Sakmar, dir. grophics engineering Michoel Olivier, grophics-product manager	QOP Computer Systems, sr. v.p. engineering QOP Computer Systems, natianal soles manager
Avis Information Services 500 Avis Or. Ann Arbor, MI 4B104 (313) 761-2B00	To supply networked computer systems and telecammunicotions equipment for offices, foctories, and institutions.	Not disclosed	Warren Avis, president, founder	Avis Rent-a-Car, founder
Bottelle Commercial Operotions 505 King Ave. Columbus, OH 43201 (614) 424-6424	To commercialize Bottelle-awned technolagy ond generate capital.	Wholly owned subsidiary of Battelle Memoriol Institute	Chorles James, president	Scientific Advances, president (current)
Combridge Soundworks 154 Californio St. Newton, MA 0215B (617) 332-9461	To build and market high-fidelity stereo speakers for the cansumer market.	Undisclased funds from private investars	Henry Kloss, chairmon, CEO Tom OeVesto, president	Kloss Video Corp., founder Tivoli Consulting, president (current)
Couldron 3204 Adeline St. Berkeley, CA 94703 (415) 654-3361	To develop and market Hummingbird saftwore for dBase developers and end-users.	Undisclosed private funds	Charles Chou, president, CEO, founder	WordTech Systems, dir. research & development
Comdisco Computing Services 430 Gothom Parkway Carlstodt, NJ 07072 (201) B96-2032	To provide transactian-oriented businesses with electronic restaration and data retrievol.	Wholly owned subsidiory of Comdisca Disaster Recovery Services	Robert Miano, president	Manufacturers Hanover Oata Services, v.p., generol manager
Consolidoted Industries 2727 Second Ave. Detroit, MI 4B201 (313) 56B-71B6	To develop nontaxic cleaning products for industriol ond institutional clients.	$5,000 from founder	Vonessa Peake, CEO, faunder	Ford Matar Company, chemist (current)
Four Pi Systems 10905 Technology Ploce San Diego, CA 9212B (619) 4B5-B551	To design, manufacture, and market outomatic inspection and process-control systems far surfoce-mount salder joints.	$3.6 millian in first raund	Robert Corey, president, CEO Bruce Boker, v.p. Michael Thiemann, v.p. marketing	IRT, division gen. mgr. IRT, mgr. product devel. Summation, v.p. marketing
Polymer Plastics 65 Oavids Dr. Hauppauge, NY 117BB (516) 231-1300	To develap resins for industry, government, and in-house use.	Wholly awned subsidiary of Polymer Plastics Corp.	Arthur Noskin, president, CEO Jules Hermele, v.p. Resin Div.	Preco Chemical, salesmon American Lova Coatings, chemis
Synoesthetics 912 N. Main St. Ann Arbor, MI 4B104 (313) 665-4430	To develop ond market persanol-computer graphics hardware and softwore far scientific and engineering uses.	Undisclosed privote funds	Ronald Westman, president W. Roy Wessel, v.p.	R.S. Westman & Assoc., president Control Data, sr. technical consultont
VMark Software Conoda 30 Centurian Dr., Markham Ontorio, Canada L3R BEB (416) 470-7157	To sell and support VMark Saftware Inc.'s Universe pragram, which enables Pick and Prime Computer software to run on Unix machines.	Wholly owned subsidiary of VMark Softwore	Joseph Lipsett, president	Joseph Lipsett & Co., president

CONTRACTS AWARDED

AWARDED TO	AWARDED BY	AMOUNT	PURPOSE
Chemfix Technologies 2424 Edenborn Ave. Metoirie, LA 70001 (504) B31-3600	City of Springfield, Mass.	$4.B million	To treat sewage sludge and process it into a usable clay-like material for landfill.
Computer Sciences 2100 E. Grand Ave. El Segundo, CA 90245 (213) 615-0311	U.S. Navy	$13.6 million	To provide softwore for the signal processor on P-3C anti-submarine aircraft.
Computer Sciences 2100 E. Grand Ave. El Segundo, CA 90245 (213) 615-0311	U.S. Navy	$30.8 million	To support satellite test vehicles, aircraft, ond other devices at the Pacific Missile Test Center in Paint Mugu, Calif.
Concurrent Computer 106 Apple St. Tinton Falls, NJ 07724 (201) 75B-7427	Unisys	$BB-million subcontract	To provide equipment for a weather rador network that would give earlier warnings of hazards such os wind shear, tornadoes, ond flosh floods.
Contel Federal Systems 12015 Lee Jackson Hwy. Fairfax, VA 22033 (703) 359-7500	U.S. Army	$14 million	To install, operate, and maintain the Army's Southeast Regian Administrative Telephone System.
Eaton AIL Commack Rd. Deer Park, NY 11729 (516) 595-5741	U.S. Novy	$45 million	To provide electronic components to improve the effectiveness of the EA-6B electronic-warfare aircraft.
EDO Government Systems 14-04 111th St. College Point, NY 11356 (71B) 445-6000	General Dynamics	$2.7 million	To develap a missile launcher for the Lockheed/General Dynamics/Boeing version of the U.S. Air Force's Advonced Tactical Fighter.
Ericsson 100 Park Ave. New York, NY 10017 (212) 6B5-4030	Kingdom of Soudi Arabia	$B7 million	To supply AXE switching ond transmission equipment and buildings for Saudi Arabia's telephone network.
GE Government Services Route 3B Cherry Hill, NJ 0B053 (609) 4B6-5174	U.S. Army	$50.7 million	To provide engineering services, including maintenance, repoir, ond construction, at facilities in Fort Corson, Colorado.
General Dynamics Box B5357 San Diego, CA 9213B (619) 547-9000	NASA ond the U.S. Deportment of Commerce	$200.2 million	To provide expendable-lounch-vehicle tronsportation services for the Nationol Oceanic ond Atmospheric Administration.
Harris 1025 W. NASA Blvd. Melbourne, FL 32919 (407) 727-9126	Newfaundland and Labrador Hydro	$5 million	To pravide a computer-bosed system for monaging electric power.
Harris 1025 W. NASA Blvd. Melbourne, FL 32919 (407) 727-9126	Americon Farm Bureau Federation	Not disclosed	To provide 500 earth stations and a master hub for o private satellite-communications network.
Harris Government Systems Box 37 Melbourne, FL 32902 (B00) 442-7747, ext. 2230	McDonnell Douglas/Generol Dynamics	Not disclosed	To provide digitol-mop equipment for the Novy A-12 progrom, which will involve attack jets based aboard aircraft corriers.

AWARDED TO	AWARDED BY	AMOUNT	PURPOSE
Integrated Network 757 Route 202/206 Bridgewater, NJ 08807 (201) 218-1600	Nynex	Not disclosed	To provide data transmission at 56 kilobits per second over the existing telephone networks of New England Telephone and New York Telephone.
Intermec Box 360602 Lynnwood, WA 98046 (206) 348-2600	U.S. Army	$100 million	To provide the Department of Defense with a bar-code data-collection system for tracking materials, containers, and documentation of non-tactical logistics operations.
Link Technologies 47339 Warm Springs Blvd. Fremont, CA 94539 (415) 651-8000	Convergent	$10 million	To design and deliver custom video-display terminals.
Masscomp 1 Technology Way Westford, MA 01886 (508) 692-6200	Lockheed Missiles & Space	$10 million	To provide Lockheed with computer systems for the Space and Naval Warfare Command's Tactical Environmental Support System.
Paradyne Box 1347 Largo, FL 33540 (813) 530-2000	U.S. Department of Transportation	$11.3 million	To maintain the Federal Aviation Administration's data-communications equipment.
Perceptronics 6271 Variel Ave. Woodland Hills, CA 91367 (818) 884-7470	Defence Advanced Research Project Agency	$6.3 million	To continue production of full-crew simulators for M-1 tanks and Bradley fighting vehicles.
Perceptronics 6271 Variel Ave. Woodland Hills, CA 91367 (818) 884-7470	Defense Advanced Research Project Agency	$1 million	To manage a program to design and build subcomponents for four reconfigurable simulators at the U.S. Army Aviation Center.
Perceptronics 6271 Variel Ave. Woodland Hills, CA 91367 (818) 884-7470	U.S. Army Research Institute	$1.7 million	To establish computer-based methods for measuring the performance of armor units in training exercises.
Quantex 2 Research Court Rockville, MD 20850 (301) 258-2701	NASA's Goddard Space Flight Center	$500,000	To develop large-area, solid-state, high-energy particle detectors based on the company's electron-trapping photonic materials.
Reynolds & Reynolds Box 2608 Dayton, OH 45401 (513) 449-4210	Chrysler Motors	$12 million	To provide interactive-video technology for training Chrysler dealers.
Singer Link Flight Simulation Corporate Dr., M.S. 244 Binghamton, NY 13902 (607) 772-3127	U.S. Air Force	$18.6 million	To provide four LANTIRN simulators for installation on existing F-16 Training Flight Simulators.
Symbol Technologies 116 Wilbur Place Bohemia, NY 11716 (516) 563-2400	Kids 'R' Us	$1 million	To install laser-based bar-code scanners in 86 stores nationwide.
TRW 1 Space Park, E2908S Redondo Beach, CA 90278 (213) 812-4722	U.S. Department of Defense	$57 million	To develop gallium-arsenide circuits for the MIMIC (microwave/millimeter-wave monolithic integrated circuit) program. TRW heads a contract team consisting of Honeywell, General Dynamics, and Hittite Microwave.
Unisys 8201 Greensboro Dr. McLean, VA 22102 (703) 847-3346	U.S Department of Transportation's Transportation Computer Center	$20 million	To provide systems programming, user support, software development, and other services to nine department offices.

ACQUISITIONS

BUYER	BUSINESS	COMPANY ACQUIRED	BUSINESS	AMOUNT
Apple Computer 20525 Mariani Ave. Cupertina, CA 95014 (4D8) 996-1010	Supplies persanal computers, peripheral equipment, and saftware	Orian Netwark Systems 1995 University Ave. Berkeley, CA 94704 (415) 649-4000	Develaps and markets saftware far camputer netwarks	Nat disclased
Applied Biamedical Sciences 320 Galden Shore Dr. Lang Beach, CA 90B02 (213) 437-6533	Makes pratein-based medical products	MediMatrix 320 Galden Shore Dr. Lang Beach, CA 90B02 (213) 437-6533	Develaps bialagical praducts far treating saft tissues	Not disclased
Arthur Andersen 59 W. Washingtan St. Chicaga, IL 60602 (312) 507-2D0D	Plans, designs, and installs camputer-based infarmatian systems	Kestnbaum & Campany 221 N. LaSalle St. Chicaga, IL 60602 (312) 7B2-1351	Creates direct-marketing strategies	Nat disclased
Cadnetix 5757 Central Ave. Baulder, CO B0301 (303) 444-B075	Supplies camputer-aided engineering, design, and manufacturing systems	HHB Systems 1000 Wyckaff Ave. Mahwah, NJ 07430 (201) B4B-B000	Develaps integrated-circuit simulatian saftware	$77 millian
Diagnastic/Retrieval Systems 16 Thartan Rd. Oakland, NJ 07436 (2D1) 337-3B0D	Makes electranic systems for anti-submarine warfare	Phatranics 270 Matar Parkway Hauppauge, NY 117BB (516) 231-9500	Produces aptical systems far military and medical uses	$15 millian
EMS Systems 1325 Capital Parkway Carralltan, TX 75006 (214) 446-2900	Designs and builds VMEbus-based camputer boards	ACS Internatianal 1325 Capital Parkway Carrallton, TX 75006 (214) 242-0BB4	Manufactures camputer and graphics praducts	Nat disclased
EMS Systems 1325 Capital Parkway Carralltan, TX 75006 (214) 446-2900	Designs and builds VMEbus-based camputer baards	DSP Technalagy 1325 Capital Parkway Carralltan, TX 75006 (214) 245-B831	Makes vaice- and data-cammunicatians equipment	Nat disclased
Ford Aeraspace Ford Road Newport Beach, CA 92660 (714) 720-1700	Produces missiles, ammunitian, and defense electranics	BDM Internatianal 7915 Janes Branch Dr. McLean, VA 22102 (703) B21-5000	Offers technical defense services	$425 millian
HHB Systems 100D Wyckaff Ave. Mahwah, NJ 07430 (201) B4B-B000	Develaps integrated-circuit simulatian saftware	Simucad 1040 Marsh Rd. Menla Park, CA 94025 (415) 321-2350	Supplies integrated-circuit simulatian saftware	$3.8 millian
Mentar Graphics 8500 S.W. Creekside Pl. Beavertan, OR 97D05 (503) 626-7000	Makes warkstatians for camputer-aided design and engineering	Cantaur Design Systems 1940 Zanker Rd. San Jase, CA 95112 (415) 325-7999	Develaps analag camputer-aided engineering saftware	$2 millian
Nava Industri A/S 301 East 57th St. New Yark, NY 10022 (212) 593-6355	Manufactures pharmaceutical drugs	Zymagenetics 2121 Narth 35th St. Seattle, WA 98103 (206) 632-4036	Canducts research an using yeast ta produce human prateins	23.2 millian
Nynex 335 Madison Ave. New Yark, NY 10017 (212) 370-7400	Sells cammunicatian services and systems	AGS Camputers' saftware services 1139 Spruce Dr. Mauntainside, NJ 07092 (201) 654-4321	Perfarms saftware engineering for businesses and financial institutions	$277 millian
Optek Technalagy 345 Industrial Blvd. McKinney, TX 75069 (214) 542-9461	Manufactures semicanductar aptaelectranic campanents	TRW's Optoelectranics Div. 1207 Tappan Circle Carrallton, TX 75006 (214) 323-2200	Builds semicanductar aptaelectranic campanents	$32.6 millian

JOINT VENTURES

COMPANY	COMPANY	PURPOSE	CONTACT
Advanced Genetic Sciences	Department of Agriculture and Rural Affairs, Victorio, Australia	To develop better crop varieties and enhance food production and quality control.	Advanced Genetic Sciences 6708 San Pablo Ave. Oakland, CA 94608 (415) 547-2395
Allied-Signal Aerospace, Bendix Electric Power Division	Ferranti Aircraft Equipment	To form Ferranti/Bendix Power Generation Ltd., which will manufacture electric-power generating systems for the aerospace industry.	Allied-Signal Box 2245R Morristown, NJ 07960 (201) 455-4674
BioTechnica International	Wacker-Chemie GmbH	To develop genetically engineered microbe systems to produce chemicals and enzyme products.	BioTechnica International 85 Bolton St. Cambridge, MA 02140 (617) 864-0040
British Aerospace	Rockwell International, North American Aircraft Division	To form a team to compete for the U.S. Air Force's proposed Tanker Transport Training System program.	British Aerospace 2101 L Street N.W. Washington, D.C 20037 (202) 857-0125
CompuDrug Ltd.	Kiser Research	To form CompuDrug USA, which will develop and sell expert-system software for use in chemical and pharmaceutical research.	Compudrug USA Box 202078 Austin, TX 78720 (512) 331-0880
Destiny Technology	Acer Technologies	To develop and market laser-printer technology and products.	Destiny Technology 930 Thompson Place Sunnyvale, CA 94086 (408) 733-3171
MacroChem	Alcolac	To test MacroChem's patented hydrophilic-lipophilic monomers, a type of water-soluble polymer, for new uses.	MacroChem 21X Olympia Ave. Woburn, MA 01801 (617) 938-6510
Silvar-Lisco	HHB Systems	To develop a new product combining technology from HHB's Cadot simulation system and Silvar-Lisco's Helix behavioral simulator.	Silvar-Lisco 1080 Morsh Rd. Menlo Park, CA 94025 (415) 324-0700
Symbolics	Sony Microsystems	To form a partnership in which Symbolics will sell and service Sony's News series of Unix technical workstations.	Symbolics 11 Cambridge Center Cambridge, MA 02142 (617) 621-7590
Union Carbide	Allied-Signal	To supply technology, systems, and services to the petroleum-refining, petrochemical, gas-processing, and energy industries worldwide.	Union Carbide 39 Old Ridgebury Rd. Danbury, CT 06817 (203) 794-6985
Union Carbide	BP Chemicals International	To form American Acetyls, which will market vinyl acetate worldwide and supply acetic acid in the United States.	Union Carbide 39 Old Ridgebury Rd. Danbury, CT 06817 (203) 794-6985
Union Carbide	General Electric	To create GE-Carbide Silicones Inc., which will combine the two companies' worldwide silicones businesses.	Union Carbide 39 Old Ridgebury Rd. Danbury, CT 06817 (203) 794-6985
University of Cincinnati, College of Business Administration	Mitsuru Wakabayoshi of Nagoya University	To study Japanese manufacturing ventures in the United States.	UC College of Bus. Admin. ML 165 Cincinnati, OH 45221 (513) 475-7120

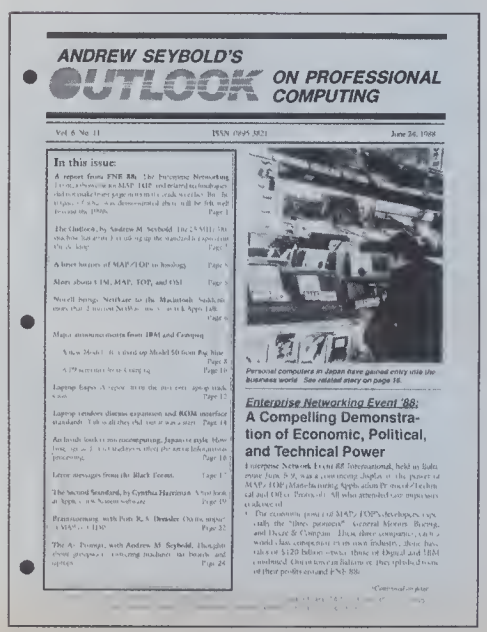
RESEARCH REPORTS

STUDY BY	TITLE	FORECAST	PRICE
Able Communications 56 Corning Ave. Milpitas, CA 95035 (408) 945-1484	ISDN Terminal Equipment (#117)	By 1992, the $18-million 1988 market for voice-only digitol units will reach $100 million, and the $30-million 1988 market for voice ond dota digital units will hit $50 million.	$1,600
Business Communications 25 Von Zant St. Norwalk, CT 06855 (203) 853-4266	Automotic Product/People Identificotion (#G-112)	Sales of autamatic identification equipment will reach $2.3 billion by 1992, ond $3.9 billian by 1997.	$2,250
Business Technology Research Bax 81210 Wellesley Hills, MA 02181 (617) 237-3111	Drug Delivery Systems	The market for such systems will grow from $1.18 billion in 1988 to $5.19 billion in 1993, representing 15.9 percent of all pharmo-ceuticols consumed in the United States.	$1,950
Catalytica Studies 430 Ferguson Dr. Mountain View, CA 94043 (415) 960-3000	Catalytic Membrane Reactors: Concepts and Applications	Identifies and reviews developments in membrone moterials and barriers to commerciolizotion.	$7,000
Diamond Research 9850 Old Creek Rd. Ventura, CA 93001 (805) 649-2209	Specialty Popers ond Films: Imaging Media for U.S. Markets	Revenues will increase from $931 million in 1987 to $1.8 billion in 1992, with loser-printer papers the largest segment.	$1,595
Frost & Sullivan 106 Fulton St. New York, NY 10038 (212) 233-1080	The Cell Controller Market in the U.S. (#A1803)	By 1991, the morket will exceed $800 million—twice its 1986 level.	$2,100
Frost & Sullivan 106 Fulton St. New York, NY 10038 (212) 233-1080	Private Satellite Business Network Terminols in the U.S. (#A1854)	The market for privote business satellites will rise from $567 million in 1987 to $1.5 billion by 1992, with the most growth in new types of networks such os business broadcasting.	$2,200
Freedonia Group 2940 Noble Rd. Cleveland, OH 44121 (216) 381-6100	Antioxidonts (#838)	U.S. sales of antioxidants for the rubber, food, lubricant, and plastics industries will rise 6.1 percent annually to reach $725 million in 1992.	$800
Input 1280 Villa St. Mountain View, CA 94041 (415) 961-3300	Federal Systems-Integrotion Morket, 1987-1992	Government demond for systems-integration and turnkey systems will reach $4.8 billion in 1992, up 16 percent onnually from the 1987 level of $2.3 billion.	$1,395
Kline & Company 330 Passaic Ave. Fairfield, NJ 07006 (201) 227-6262	Irradiotion-Resistant Pockages	The market for such packaging for use in dispasable medical devices and food products will hit $320 million by 1992.	$5,000
Market Intelligence Research 2525 Chorleston Rd. Mountoin View, CA 94043 (415) 961-9000	Industrial Material Processing Laser Markets: Growth Applicatians and Industries (#A099N)	1988's estimated market of $67.5 million will grow to $85 million by 1994.	$995
Newton-Evans Research 3220 Corporate Court Ellicott City, MD 21043 (301) 465-7316	Corporate Strategies in the U.S. Computer Industry, Volume I: The 8illion-Dollor Club	Presents profiles and anolyses of 14 computer-industry companies that had 1987 revenues of more than a billion dallars.	$395
Technology Futures 6034 W. Courtyard Dr. Austin, TX 78730 (512) 343-6468	Technological Substitution in Transmission Facilities for Local Telecommunications	8y 1995, 99 percent of inter-office circuits will be provided on metallic and fiber digital-carrier systems.	$1,495

KNOWLEDGE IS POWER
IS MONEY

ANDREW SEYBOLD'S OUTLOOK ON PROFESSIONAL COMPUTING

It costs less than a dollar a day for an outlook that can save you thousands of dollars in computer costs.


ANDREW SEYBOLD'S
OUTLOOK ON PROFESSIONAL COMPUTING

Vol. 6 No. 11 — June 24, 1988

In this issue:

Personal computers in Japan have gained entry into the business world. See related story on page 16.

Enterprise Networking Event '88:
A Compelling Demonstration of Economic, Political, and Technical Power

A single mistake on professional applications of computers can cost your company thousands, even tens or hundreds of thousands of dollars in equipment costs, training, and retraining, as well as in reduced worker productivity.

The way to make the right decision the first time is by having authoritative, useful information to tell you what's REALLY going on in the computer industry—so you can plan your own strategy accordingly.

That's what you get from *Andrew Seybold's Outlook on Professional Computing*, the most widely read publication of its kind covering the personal-computer industry.

Every month, you can count on *Andrew Seybold's Outlook* for in-depth reviews of products that help shape the direction of the industry, plus analytical perspectives to help you determine which products are right for your company. It's the kind of perspective that helps you plan the future in a cost-effective way—and keeps you from making costly mistakes that could compromise the future.

Write or call now for a free sample issue of *Andrew Seybold's Outlook on Professional Computing*.

☐ Please send me a FREE sample of *Andrew Seybold's Outlook on Professional Computing*.
☐ Send me 12 monthly issues, mailed first class, for $360 U.S. ($372 Canada, $384 foreign).
____ Amount enclosed. ____ Bill me.

A division of
Infotechnology Publishing Corp.

3235 Kifer Road, Suite 110
Santa Clara, CA 95051
(408) 746-2555

NAME _____
TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____
PHONE _____

INDEXES

The following list does not include Marketwatch, the High Technology Business Leading 100, Newsletter Digest, and New Products

COMPANY

SUBJECT

BUSINESS/TECHNOLOGY CENTER

SAMPLE AD

YOUR
LOGO
HERE

To place your 1/9 ad in this section, send us a photo of your product or your logo. Include your copy of no more than 200 characters and a heading of no more than 14 characters.

To place an ad, *call Jennifer Battikha, High Technology Business* magazine, (617) 723-6611.

Place your ad in this space . . . and reach nearly 170,000 upscale, corporate decision-makers for one full month.

Business/Technology Center lets you:

- advertise new products
- test new markets
- receive valuable leads
- distribute product information
- offer free samples

Business/Technology Center

To reach corporate decision-makers who ACTIVELY pursue business information in all areas of high technology, there is NO OTHER place to go but *High Technology Business* magazine. Inquiries about the ads in *High Technology Business* magazine skyrocketed 160 percent from September to October 1987.

For more information *call Jennifer Battikha* at *High Technology Business, (617) 723-6611.*

Advertise in the CENTER and get results...

When you advertise in the Business/Technology Center, your ad will reach nearly 170,000 corporate decision-makers who actively pursue business information in all areas of high technology.

To find out more, *call Jennifer Battikha* at *High Technology Business* magazine, (617) 723-6611.

Business/Technology Center

Advertise in the Business/Technology Center—the special section our readers turn to for purchasing ideas on the latest technology products.

1X $1,500	3X $1,300
6X $1,100	12X $900

GET VALUABLE LEADS

By advertising in the Business/Technology Center, you'll gain important information on prospective clients by receiving a free circle number.

To place an ad, contact *Jennifer Battikha* at *High Technology Business* magazine, 214 Lewis Wharf, Boston, MA 02110, or call (617) 723-6611.

Reach nearly 170,000 upscale, corporate decision-makers for one full month. Place your 1/9 ad in the Business/Technology Center by following these easy steps:

1. Send us a black-and-white photo of your product, or a copy of your logo.
2. Include copy of no more than 200 characters and a heading of no more than 14 characters.
3. Fill in the form below. We do the rest!

- ***Your company will be given a FREE circle number to receive valuable leads.***

Send this form with materials to Business/Technology Center, Jennifer Battikha, *High Technology Business* magazine, 214 Lewis Wharf, Boston, MA 02110, or call (617) 723-6611.

Name _____

Company _____

Address _____ City _____

State _____ Zip _____ Phone _____

Mail Minder, Movable Hard Disk

AUTO

Remote-control car warmup

IF YOU DON'T have a chauffeur to ready your car on cold winter mornings, the AutoCommand remote-control starter can warm the engine for you.

This transmitter, which is about the size of a matchbook, starts a car from as far away as 400 feet, and also turns on the heater, defroster, air conditioner, or windshield wipers, according to the driver's command. The device send radio signals to an electronic control module wired to the ignition system.

To thwart thieves, an AutoCommand-equipped vehicle shuts off if the key is not inserted into the ignition within 10 minutes, or if the brake, accelerator, or gear selector is moved.

Drivers negotiating labyrinthian parking garages can set the device to sound a whistle and flash headlights to alert others. Also, sustained pressure on the transmitter button starts a siren and flashes lights to ward off potential attackers. The $299 automatic starter operates only in vehicles that have fuel-injected engines and automatic transmissions.

For more information, contact DesignTech International, located at 941-B 25th Street Northwest, Washington, DC 20037. Phone (202) 333-0078.

—Jennifer Christensen

This sensor-equipped mailbox sings when full.

OFFICE

Have hard disk, will travel

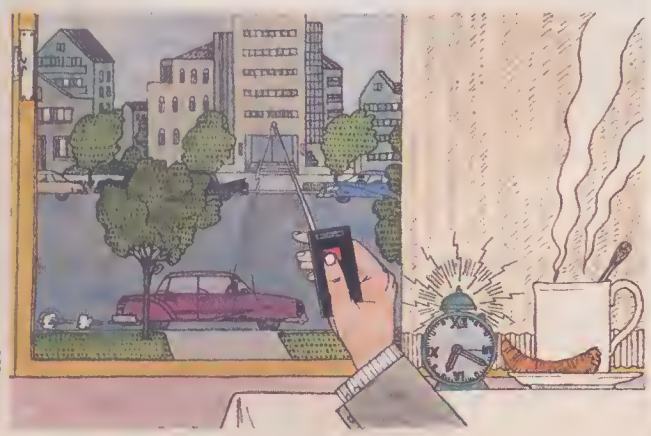
JUGGLING computer files to floppy disks can be frustrating when it's the only way to transfer data from your office hard disk to your home computer. One solution is the Plato Hardpac 20, a hard disk that can be easily transported from one computer to another.

The product, which is manufactured by Aristotle Industries Inc., is an external 20-megabyte hard disk that connects and disconnects quickly by cable to a personal-computer port. About the size of a pocket novel, the 2.2-pound disk works with the Apple Macintosh and with IBM-compatible personal computers. Later this year, Aristotle Industries plans to offer versions for laptop computers and for the Commodore Amiga.

To use the Plato disk, IBM-compatible computers need an internal board called the host adapter. Macintoshes require an "external interface." These add-on devices adapt any personal computer, with or without its own hard disk, to read and write data on the portable disk.

The basic disk, with adapter and cable, retails for $785. For more information, contact Aristotle Industries in Canada at 100-6975 18th Ave., Burnaby, British Columbia V3N 4L1, or telephone (800) 663-2237.

—Elizabeth Aaron



DEVIS GREBU

HOME

Radio checks the mail

THE SIGNAMAIL electronic signaler is the high-tech solution for people with long driveways who are tired of guessing when their mail has arrived.

The product consists of a transmitter and receiver set that works with any curbside mailbox, according to Signamail Systems Inc. The small transmitter—bonded to the door of the mailbox with double-sided tape—sends a signal to a receiver inside the home when the postman closes the mailbox. Fifteen seconds of Beethoven's *Fur Elyse* and a green light alert the homeowner that the mail has arrived. The light stays on until the receiver is reset, a reminder for those who might have missed the musical serenade.

The transmitter runs off a 9-volt battery, and the receiver plugs into a wall socket. A rugged plastic cover is designed to ensure that neither snow nor sleet nor hail will keep the transmitter from its appointed rounds.

The $49 system works in mailboxes that are as far as 500 feet from the receiver and comes with coded frequencies, like those used in garage-door openers, to avoid signal interference from neighbors who may also own a Signamail.

Signamail Systems' address is 204 East Second Ave., San Mateo, CA 94401. Phone (415) 340-0126.

—Kenan Woods

IEEE VIDEOCONFERENCES
SEMINARS VIA SATELLITE

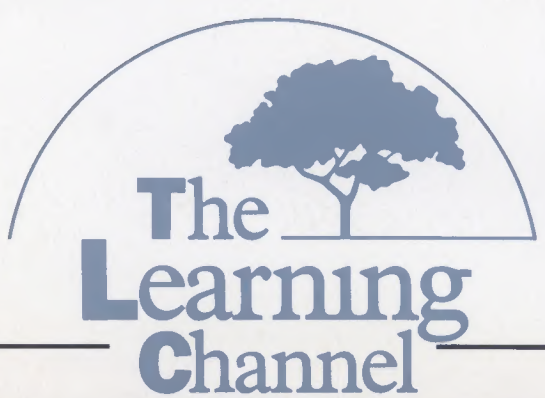
KEEP UP WITH TECHNOLOGY

The Institute of Electrical and Electronics Engineers, Inc. (IEEE), the world's largest transnational technical society, provides you with an exciting learning experience. Via satellite, we bring the experts directly to you to discuss the latest advances in the world of technology. This year our schedule of programs includes:

- **PHOTONIC SWITCHING**
  September 22, 1988
- **SUPERCONDUCTIVE MATERIALS**
  October 20, 1988
- **SUPERCOMPUTERS**
  December 7, 1988

Produced and distributed by The Learning Channel, cable television's premier educational channel, these interactive programs are transmitted to sites in North America, the Caribbean and Europe.

To find out how you can receive these programs via satellite for a nominal fee write: IEEE Continuing Education Department, IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331 or call (201) 562-5494.



XEROX

Introducing the more or less perfect copier. It does more. You do less.

The Xerox 5046.
It gives you big machine features with small machine ease.

To mark 50 years of innovation in document processing, we're introducing yet a further innovation. The new Xerox 5046. A mid-size copier that's so productive it sets a whole new standard in document processing.

The 5046 gives you more. More quality ...copies you can't tell from originals. More speed...a prolific copying rate of 35 CPM, even on double-sided copies. More features...collating, stapling, editing, reducing, enlarging. Even a document handler that feeds mixed-size originals together.

And the more it does, the less you do. Because the message display walks you through step by step. And, for the first time in a mid-size copier, you get a copy cartridge you can change as easily as changing a light bulb.

All this is backed by the expertise and support you can only get from Team Xerox, world leader in document processing. To find out how the Xerox 5046 can make the processing of your documents more productive than ever before, call 1-800-TEAM-XRX, Ext. 284.

Team Xerox.
We document the world.

I'd like to learn more about the new Xerox 5046.
☐ Please send me more information.
☐ Please have a sales representative contact me.
Send this coupon to:
Xerox Corporation, P.O. Box 24, Rochester, NY 14692

NAME Please Print

TITLE

COMPANY

ADDRESS

CITY

STATE 184-09-88 ZIP

If you can't wait, call
1-800-TEAM-XRX, Ext. 284
(1-800-832-6979, Ext. 284)

XEROX® and 5046 are trademarks of XEROX CORPORATION.

Official Sponsor of the XXIV Olympic Games

USA Official Sponsor of the U.S. Olympic Committee 36 USC 380

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 68 BOULDER, CO

POSTAGE WILL BE PAID BY ADDRESSEE:

High Technology Business
P.O. Box 51488
Boulder, Colorado 80321-1488